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The equity premium puzzle and myopic loss aversion in Europe

A comparative empirical study of the equity premium and non-standard investor preferences in Scandinavia and selected European countries

By Anders Frank Christensen

Advisor: Lisbeth Funding la Cour

Department of Economics

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Executive summary

The relation between asset returns is at the heart of economic and financial theory, with the central premise being that market prices, and returns, are derived from the interaction between rational and utility maximizing agents. In 1985, Mehra & Prescott published an influential study that illustrated how the observed equity premium in the US had been substantially above what standard utility theory would predict. This was labeled the equity premium puzzle, and it has been a source of debate ever since.

This paper investigates a potential approach to solving the puzzle, namely myopic loss aversion, as presented by Benartzi & Thaler in 1995. The approach builds on elements from the field of behavioral finance, along with a non-standard investor preference structure developed Tversky & Kahneman (1979; 1992) as part of their renowned prospect theory.

Firstly, the study extends the original analysis of Mehra & Prescott (1985) to the three Scandinavian countries, along with six other EU countries of varying size, selected to provide a strong and robust comparative European context. For the sample period 1970-2010, it is found that an equity premium puzzle is present throughout the nine countries included in this study.

Next, the study applies the myopic loss aversion approach of Benartzi & Thaler (1995), to investigate whether it can serve as a broadly founded solution to the observed puzzles. The analysis shows that this is not the case. While myopic loss aversion can explain the observed equity premium in Sweden, and to some extent in Norway and Denmark, the approach fails to provide a viable solution for the six non-Scandinavian countries in the sample. Consequently, the overall conclusion from the comparative analysis is that myopic loss aversion cannot provide a solution to the equity premium puzzle observed within the nine countries over the period 1970-2010.

To understand these results, sensitivity tests are performed for changes in the key model input, loss aversion, as well as the sample period. While changes in loss aversion are shown to have considerable impact on the results, the magnitude of change needed for the approach to work, makes the solution implausible. Meanwhile, the change in sample period provides a stronger picture, as an investigation of the return data shows a change in the pattern of equity returns over the last 10 years. Adjusting for this period provides strong support for the myopic loss aversion approach across all countries analyzed. However, as 10 years cannot be described as an outlier, the overall conclusion remains unchanged. Within this comparative analysis, myopic loss aversion fails to provide a convincing solution the equity premium puzzle.

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1 Introduction

The relationship between risk and return is central to the world of finance. Financial theory is based on the assumption that with increased risk, the investor will require more compensation through additional return. The existence of an equity premium is therefore not in itself a surprise but rather a required balance. As rational agents seek to maximize their utility, the equity premium is an expression of how volatile and risky equity investments provide a lower utility than their safe risk free alternative, leading the investor to require additional returns.

In 1985, Mehra & Prescott published a pioneering study of the empirically observed relationship between risk and return in US capital markets. The authors modeled asset returns using a traditional utility approach, and compared their results to the actual observed returns. The conclusion was as surprising as it was decisive; the observed premium on equities far exceeded the premium predicted by the utility model – an imbalance the authors labeled the equity premium puzzle.

Following this publication, a wide range of possible explanations have been presented. While some have focused on the assumptions of the model, others have attempted to account for imperfect markets, and in turn some have pointed to biases in the data. Finally, a group of authors have sought to solve the puzzle by suggesting an alternative preference structure of the representative investor.

Among this last group, Benartzi & Thaler (1995) introduced the use of an approach called myopic loss aversion, wherein the authors employed a preference structure based on empirically observed behavioral patterns, thereby replacing the normative axioms that are assumed to govern rational decision making under traditional utility theory. The alternative preference structure was adapted from a line of experimental studies performed by Tversky & Kahneman (1979; 1992), and by modeling these preferences, Benartzi and Thaler (1995) were able to provide a credible solution to the equity premium puzzle in the US.

Although the equity premium puzzle and its potential solutions have received considerable academic attention, the vast majority of the research has been focused solely on US asset markets. The aim of this paper is therefore twofold; to analyze the existence of equity premium puzzles in a comparative European and Scandinavian context, and furthermore to explore whether myopic loss aversion can explain the observed investor behavior in non-US countries.

1.1 Problem statement

To investigate the risk and return relationship in a broad international setting requires some delimitation in scope. The focus of this paper is to explore equity premium puzzle, and subsequently myopic loss aversion as a potential solution to such puzzles, in a European -and particularly Scandinavian - context. On this basis, nine countries have been selected for analysis. The group consists of the Scandinavian countries; Denmark, Norway, and Sweden, along with six countries that provide a European context, namely; Belgium, France, Germany, Netherlands, Switzerland and the UK. These six countries are included in the analysis to provide the best possible reference base for comparison, by covering both small open economies such as Belgium and Netherlands, which are also more similar to the Scandinavian group, as well as the larger and more dominant countries from the region. Collectively the group provides a strong and robust basis for comparative conclusions.

The analysis will only focus on the period from 1970 to 2010. This period provides a solid quantity of data, while still keeping a fair periodic resemblance to the current environment, making the conclusions relevant also in a forward looking perspective.

On this basis the analysis is structured around two main research questions. Firstly, regarding the equity premium puzzle:

1) *Can the utility based model explain the observed equity premium over the period 1970 to 2010 in nine specific European countries, or can an equity premium puzzle be documented?*

Based on the existing research it is somewhat expected that most of the countries will exhibit some magnitude equity premium puzzles. Therefore, the second question relates to the validity Benartzi & Thaler's (1995) model of myopic loss aversion as a solution to the puzzle:

2) *Can myopic loss aversion explain the observed equity premia in the nine European countries, and thereby be validated as a broadly founded solution to the equity premium puzzle?*

Through these questions this paper aims to contribute to the academia by expanding the empirical foundation relating to the equity premium discussion. Specifically, the comparative nature of the analysis should provide a strong and unprecedented test of the robustness and merit of the models analyzed.

1.2 Methodology and delimitations

The paper is divided into three main sections. The first presents the theoretical basis and results of the equity premium puzzle model from Mehra and Prescott (1985). The section also reviews other empirical evidence pertaining to the puzzle, with a particular focus on existing international research. Lastly, the section presents key literature related to proposed solutions to the puzzle, ending with myopic loss aversion.

The second section presents the intuition behind Benartzi and Thaler's (1995) myopic loss aversion approach, and its theoretical foundation, namely prospect theory. Subsequently, the results of the original US study are presented, along with the additional existing empirical evidence. Lastly, the section presents the most central documented critique of the approach in itself.

Finally, the third section presents the empirical analysis. This includes a review of the data and sources used, as well as the technical methodology related to each of the models used for analysis, before presenting the empirical results. Lastly, the section presents a range of additional analyses that serve to test the robustness of the method, before providing a conclusion.

The main theoretical foundation of this paper is the original formulation of the applied models – namely the equity premium puzzle by Mehra & Prescott (1985), and myopic loss aversion by Benartzi & Thaler (1995).

The paper has a number of delimitations. As the comparative study provides its primary value through the empirical results, the literary review of the equity premium puzzle has been limited to presenting key articles from the field that are directly related to analysis to provide the reader with the necessary understanding. For a more complete literature review, references are made to other publications. The analyses are strictly focused on testing the specific models and their robustness, as this alone provides a large amount of empirical output when analyzing a sample of nine countries. Alternative approaches are therefore not tested or taken into account. Also, the analysis will not attempt to explain the drivers behind underlying data e.g. what have caused equity market crashes or differences in country performance, but instead focus on the conclusion drawn from the empirical observations. Likewise, no attempts are made to remove or adjust for outlier events as these are at the heart of the actual development in capital markets, which is the topic of the study.

2 Equity Premium Puzzle

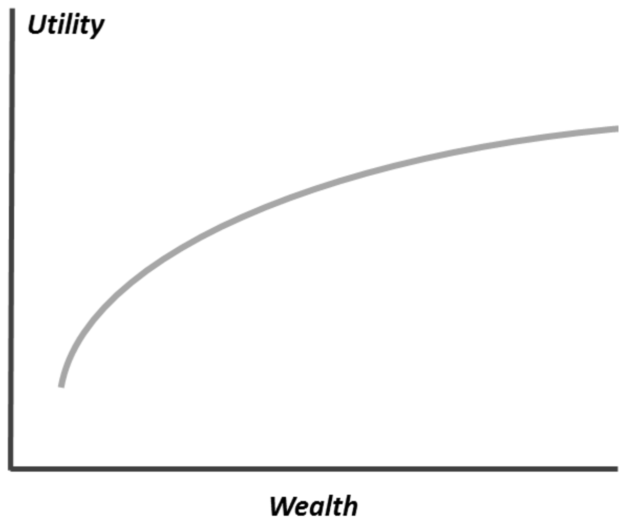
The equity premium puzzle has long been a source of debate in economic literature, and it nearly constitutes a literary sub-branch in itself given the vast quantity of research on the topic. The puzzle is generally originated to the pioneering article “The equity premium – a puzzle” by Mehra & Prescott (1985). The article showed how the observed return relationships between asset classes contrasted the prediction of a traditional asset pricing model, which was based on classic utility theory. The traditional model predicted an equity premium based on the greater levels of risk when trading equities (compared to risk-free assets) however the theoretically explained premium was far below the empirically observed premium for the period in question. This implied that investors were more risk averse than theory predicted, and that they required an unexplainably high reward for the additional risk of holding equities. As the difference between the explained and observed premium was so significant, the authors termed the finding as the equity premium puzzle – a subject that more than 25 years later is still debated across academia and investment practitioners.

2.1 Mehra & Prescott - “The equity premium – a puzzle”

Mehra & Prescott’s (1985) analysis investigated the relation between returns in the stock market and returns from a risk free investment alternative – specifically short dated Treasury Bills. The central factor was the estimation of the compensation (excess return) that investors have required to carry the risk of holding stocks. The approach was based on a traditional consumption capital asset pricing model (CCAPM) originally presented by Lucas (1978), where utility theory governs the behavior of rational investors, assumed to be risk averse and utility maximizing. Assuming no transaction cost and efficient markets, rational investors are assumed to price assets based on the equilibrium where the utility given up at time zero – money spent on investments rather than on consumption - matches the expected future utility gain of the investment. The CCAPM builds on the fact that the marginal utility of an outcome changes over time, depending on the state of the agent. Specifically, the utility gain of receiving a financial return is driven by the level of consumption at the time.

The standard utility function is a concave function of wealth (Figure 2.1) where marginal utility is represented by the slope – meaning how much additional utility a person gains from one additional unit of wealth. This implies that the marginal utility of a financial gain is higher when the base state is low (i.e. where the slope is higher).

Figure 2.1 – Classic Utility Function



This relationship is also the basis in the CCAPM, where investors obtain varying degrees of utility from the financial returns, depending on their consumption. In this way, asset pricing is related to the asset's covariance with consumption – represented by a consumption beta. Assets that provide gains when consumption is low are valued higher than assets that follow the development of consumption. As equities generally follow the general fluctuations in consumption – rising when consumption grows – they are priced with a relative discount to risk-free assets that provide more constant returns. In turn, the lower price provides an increased return, leading to a predicted theoretical premium.

Mehra & Prescott (1985) applied this model to the empirical returns of equities and risk free assets (US T-Bills). In the application of the model one assumption was altered – where Lucas (1978) originally assumed that overall consumption levels follow a stochastic process, Mehra & Prescott (1985) changed the assumption to state that consumption growth is itself followed a stochastic process. This allowed for underlying growth in general consumption, consistent with the empirical observation. Assuming still that there are no transactions cost and that markets are efficient, the investment decision is maximized by the equation 2.1.

$$(\mathbf{2.1}) \qquad E_0\left\{\sum_{t=0}^{\infty}[\beta^t U(c_t)]\right\}, \qquad 0<\beta<1$$

In this equation E_0 describes the expected future utility perceived at time zero, and $U(c_t)$ describes the utility of consumption at time t. β^t is a factor describing the time decay of utility for the investor due to impatience, where 0 imply that the investor has no value of future utility and 1 conversely implies that the investor is indifferent between utility now and later. The equation assumes that investors always maximize future utility regardless of age meaning that investors behave as if their life expectancy was infinite. In a strictly individual framing this assumption seems challenging, but by including heritage and legacy considerations that allow for passing of future utility to children, charities, etc., the assumption seems reasonable.

The utility function in the model is based on a constant relative risk aversion, implying that the perception of risk is persistent, and not influenced by external factors. The function is described in equation 2.2, where α is the coefficient of relative risk aversion (CRRA) for the investor, describing the decreasing utility from consumption related to risk aversion.

$$(\mathbf{2.2}) \qquad U(c,\alpha) = \frac{c^{1-\alpha}-1}{1-\alpha}, \qquad 0 < \alpha < \infty$$

As visible from appendix A, the risk aversion is linked to the elasticity of intertemporal substitution (EIS), defined as $\frac{1}{\alpha}$, which describes the sensitivity to changes in consumption. As alpha increases, the elasticity of substitution of consumption in time decreases, meaning that the sensitivity to changes in consumption is higher. Therefore, the risk adverse investor is highly sensitive to swings in consumption, and will seek to smooth consumption over time and over economic cycles.

As investors maximize utility, the equilibrium asset price is found where the utility of consumption lost from investing now matches the expected utility in the future, based on the investment return. More concretely, the investor has a utility loss at time t equal to the price of the investment asset (p_t) times current marginal utility ($U'(c_t)$). This “loss” must be compensated in the future, where the gain is equal to the future price p_{t+1}, along with any dividend yield from the asset y_{t+1}. In utility terms, the risk adverse investor experiences the future utility as:

$$\textbf{(2.3)} \qquad \beta E[(p_{t+1}+y_{t+1})\, U'(c_{t+1})]$$

The expected gain, discounted by the impatience factor (β), times the marginal utility of consumption at the time of the gain ($t+1$). On this basis, the equilibrium is found through condition 2.4, where these expressions equate:

$$(\mathbf{2.4}) \qquad p_t U'(c_t) = \beta E[(p_{t+1}+y_{t+1})U'(c_{t+1})]$$

In this terminology, the expected return $R_{e,t+1}$ is given by the future price plus any dividends $(p_{t+1} + y_{t+1})$, divided by the current price (p_t).

$$(\mathbf{2.5}) \qquad R_{e,t+1} = \frac{(p_{t+1} + y_{t+1})}{p_t}$$

Appendix B shows that these expressions can be re-written to form the return expressions in the CCAPM format, used in the Mehra & Prescott (1985) model described in expression 2.6:

$$(\mathbf{2.6}) \qquad R_{e,t+1} = R_{f,t+1} + Cov_t\left[\frac{-U'(c_{t+1}), R_{e,t+1}}{E_t[U'(c_{t+1})]}\right]$$

This relation implies that the expected return on equities is given by the return on the risk free asset, and a risk premium determined by the covariance between equity and the marginal utility of consumption (Mehra & Prescott, 2003). The key point is that a high level of covariance between equities and consumption leads to a high premium, as these assets will not "hedge" disruptions in consumption, but instead strengthen the disfavored volatility.

The final step in the analysis is to introduce the growth in consumption element defined as x_{t+1}, equivalent to $\frac{c_{t+1}}{c_t}$. In appendix C it is shown that including this consumption growth component to the pricing relation in the model, yields the following expressions for risk free and expected equity returns, based on expected consumption growth and risk aversion:

$$(\mathbf{2.7}) \qquad R_{f,t+1} = \frac{1}{\beta E_t(x_{t+1}^{-\alpha})} \qquad (\mathbf{2.8}) \qquad E(R_{e,t+1}) = \frac{E_t(x_{t+1})}{\beta E_t(x_{t+1}^{1-\alpha})}$$

As stated earlier, the big difference between the classical consumption CAPM and the version of Mehra & Prescott (1985) was the change in consumption assumption. Where the classical model was built on an assumption of stochastic consumption, the model of Mehra & Prescott assumed instead a stochastic consumption growth, to allow for the general rising consumption seen empirically over time. As part of this stochastic consumption growth assumption, the authors also assumed the growth to have a lognormal distribution. As shown in appendix C, based on the lognormal distribution of the consumption growth (x_{t+1}), the expected equity return can be re-written to equation 2.9:

$$(\mathbf{2.9}) \qquad E_t(R_{e,t+1}) = \frac{e^{\mu_x + 1/2\sigma_x^2}}{\beta e^{(1-\alpha)\mu_x + 1/2(1-\alpha)^2\sigma_x^2}}$$

By taking the natural logarithm to both sides of the equation, the expression can be reformulated to:

$$(\mathbf{2.10}) \qquad \ln E_t\left(R_{e,t+1}\right) = -\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2 + \alpha\sigma_x^2$$

In this expression μ_x is equal to $E(\ln x)$, which is the mean of consumption growth, and σ_x^2 is the variance of the consumption growth. Following the same procedure, the risk free return can be re-written to equation 2.11:

$$(\mathbf{2.11}) \qquad R_{f,t+1} = \frac{1}{\beta e^{-\alpha\mu_x + 1/2\alpha^2\sigma_x^2}}$$

This can likewise be restated to:

$$(\mathbf{2.12}) \qquad \ln R_f = -\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2$$

It is based on these expressions that the model of Mehra & Prescott (1985) defines the explainable equity risk premium as the risk aversion of the investor times the variation of consumption growth:

$$(\mathbf{2.13}) \qquad \boldsymbol{\ln E(R_e) - \ln(R_f) = \alpha\sigma_x^2}$$

2.2 Mehra & Prescott - Equity premium puzzle findings

Using the above approach, Mehra & Prescott (1985) analyzed the equity and risk free returns in the US over the period 1889-1978. For equity returns, they used the annual real return on the S&P500 total return index, risk free returns were found through real annual returns from 3M Treasury Bills, and for consumption growth they used annual growth in consumption per capita. The sample statistics of are presented in Table 2.1:

Table 2.1 - Mehra & Prescott data characteristics

Mean real risk-free rate	0.8%
Mean real equity return	6.98%
Mean real growth rate of consumption	1.8%
Stdev. of real consumption growth	3.6%
Mean observed equity premium	6.18%

In order to find the explained equity premium, estimates for α and β were chosen. As these variables describe individual investor preferences, they are subjective in nature. General estimates for risk aversion at the time ranged between 1 and 2 (Mehra & Prescott, 1985), however to get a stronger robustness to their argument they set α to 10 – a far larger risk aversion. As such an alpha will have an increasing effect on the expected returns (equation 2.10 and 2.12), the estimate for beta was set to 0.99, providing the least possible add-on effect, as investors are then assumed to be almost indifferent between consumption now and in the future. Inserting these estimates into the model provided an estimate of the explained equity premium:

Risk free return (2.12):

$$\ln R_f = -\ln(0.99) + 10 * 0.018 - \frac{1}{2} * 10^2 * 0.036^2 = 0.120 => \boldsymbol{R_f = 12.7}\%$$

Equity return (2.10):

$$\ln E(R_e) = 0.120 + 10 * 0.036^2 = 0.132 => \boldsymbol{E(R_e) = 14.1}\%$$

The absolute levels obviously differ largely from the observed (0,8% vs. 12,7% for the risk free return), however this is not important due to the effect of the large alpha on the absolute estimates. What is interesting is the relationship between the two returns in the model, compared to the observed equity premium. The explainable equity premium is much below the observed:

Table 2.2 - Mehra & Prescott equity premium puzzle

Result	Observed data	Model results
Equity return	6.98%	14.1%
Risk-free rate	0.8%	12.7%
Equity premium	6.18%	1.4%

Equity premium puzzle = 6.18% - 1.4% = 4.78%

In sum, the finding of Mehra & Prescott (1985) was that even with a risk aversion much above the expected level, traditional theory could only explain a marginal premium in comparison to the actual observation. They therefore labeled this imbalance the equity premium puzzle, a subject discussed ever since.

2.3 Other empirical evidence of an equity premium

As noted, the pioneering work by Mehra & Prescott (1985) sparked a large interest in academia and among economics and finance practitioners on the subject and related areas. The quantity of work within the field is so large that it is not possible to cover. Instead the following presents highlighted empirical evidence, in regards to the equity premium puzzle.

An important paper on the puzzle was published by Kocherlakota in 1996. By approaching the puzzle from a different angle, the paper used US data for the same period as Mehra & Prescott (1985), and showed that the risk aversion parameter α must be above 8.5, before the observed equity premium can be explained by consumption growth (Kocherlakota, 1996). Below 8.5, the equity premium was significantly different from the expected premium driven by consumption growth. Kocherlakota (1996) highlighted that the reasonable alpha boundary of 1-2 presented by Mehra & Prescott (1985) was not reflective of reality, and argued that a relative risk aversion coefficient in the range 5-10 represented improbable investor behavior – reaffirming the equity premium puzzle.

Additional evidence on the subject was provided by Weil (1989), who described another interesting dimension, namely the risk-free rate puzzle. While the evidence on the broader equity premium was convincing, it was not conclusive as it relied on the estimated level of risk aversion, which is not observable. Weil's argument was related to the risk-free rate, and the fact that investors' wish to smooth consumption over time. With growing consumption, the risk adverse investor will seek to smooth the utility through time, by borrowing in the present against his future consumption. Contrastingly, variation in consumption will lead invertors to save current utility for future periods (investing in risk-free assets), under the same utility smoothing motivation. These factors, along with the impatience factor beta, should effectively explain the expected risk-free rate – or the price of borrowing. Weil's insight was that under the observed consumption growth[1], which has been quite smooth over time (standard deviation of 3.6%), the risk aversion needed explain the observed real risk-free rate (0.8%) would be above 40 - a level naturally argued to be unimaginable. In sum, risk aversion can explain the observed equity return for risk aversion coefficients within the imaginable range, but the risk-free rate cannot be plausibly explained – a perspective he called the risk-free rate puzzle (Weil, 1989).

2.4 International evidence of an equity premium

On the subject of international equity premia, the work of Dimson, Marsh and Staunton (DMS) has been, and continue to be, the most influential (Dimson, Marsh, & Staunton, The worldwide equity premium: A

[1] Observed mean growth of consumption of 1.8%

smaller puzzle, 2008). When considering international equity premia, the most important factor is the quality of data, and this is where DMS have developed a very comprehensive database (DMS database[2]).

The general issue with data quality is that many countries do not have available equity and interest data stretching far back in time. Therefore, DMS have worked with researchers in each country to compile a comprehensive database, which is usable for comparative analysis going back to 1900. The DMS database is also the source used for the Global Investment Return Yearbook published by Credit Suisse and London Business School, which is a primary equity premium publication used by investment professionals. It is important to note that the authors analyze the magnitude of the country equity premium over time, and not the size of the equity premium puzzle. The existence of equity premia does not in itself constitute a violation of the standard consumption CAPM. However, comparing the size of reported premium, with known evidence regarding the US equity premium puzzle, provides a picture of the asset return relation in the different countries. DMS report significant equity premia across the 17 countries analyzed in the period 1900-2010 (Table 2.3). Also Kyriacou, Madsen & Mase (2004) have investigated international equity premia, and found that the equity premium reported in the US is mirrored internationally.

[2] The DMS data is distributed by Morningstar Inc. and only available through licensed purchase

Table 2.3 - International equity premia

Country	Dimson, Marsh & Staunton (2011) 1900-2010	Kyriacou, Madsen & Maze (2004) 1900-2002	Barro (2006) 1954-2004
Australia	6.8%	6.9%	
Belgium	2.9%		
Canada	4.1%	6.2%	5.0%
Denmark	2.5%		
Finland	5.7%		
France	6.1%	9.9%	7.2%
Germany	5.8%	5.2%	8.0%
Ireland	3.1%	7.6%	
Italy	5.9%	8.7%	5.1%
Japan	5.9%		8.3%
Netherlands	4.2%	6.8%	
Norway	2.9%		
Spain	3.4%		
Sweden	4.2%		
Switzerland	3.4%		
UK	4.2%	5.2%	7.9%
US	5.2%	6.9%	7.6%

Regarding analysis of equity premium puzzles internationally, there has only been limited research. In 2006, Barro published a paper analyzing the puzzle with a CCAPM model similar to Mehra & Prescott's approach. Barro's results supported the evidence from the US (Barro, 2006).

Based on the above literature it may be concluded that the equity premium puzzle is well established with regards to the US, and that empirical evidence supports the existence of substantial equity premia internationally.

2.5 The equity premium over time

As the existence of an equity premium became thoroughly validated and accepted, attention was turned to the development and the nature of the equity premium over time, both amongst academics and investment professionals.

Again, in an international context the work of Dimson, Marsh & Staunton (DMS) has provided vast empirical analysis (Dimson, Marsh, & Staunton, 2011). As visible from Table 2.4, the authors have found that equity premia in general have changed dynamically over time during the last century, but that they remain substantially positive for all investigated countries. While there is not a general directional tendency, it is worth noting that the equity premium has fallen substantially in some countries, namely in Australia, Canada, Germany, Italy, and Japan.

Table 2.4 - Dimson, Marsh & Staunton (2011): International equity premiums over time

Country	1900-2010	1960-2010	1970-2010	1980-2010
Australia	6.8%	3.4%	**2.0%**	3.4%
Belgium	2.9%	1.6%	**2.4%**	3.9%
Canada	4.1%	2.8%	**2.2%**	2.1%
Denmark	2.5%	2.8%	**3.5%**	4.8%
Finland	5.7%	4.8%	**5.8%**	6.5%
France	6.1%	3.6%	**4.4%**	5.8%
Germany	5.8%	2.4%	**2.2%**	3.8%
Ireland	3.1%	4.4%	**3.2%**	3.0%
Italy	5.9%	0.9%	**1.1%**	4.4%
Japan	5.9%	3.2%	**2.1%**	0.5%
Netherlands	4.2%	4.4%	**4.7%**	6.3%
Norway	2.9%	3.4%	**4.2%**	3.5%
Spain	3.4%	4.5%	**2.7%**	7.9%
Sweden	4.2%	5.6%	**6.3%**	8.5%
Switzerland	3.4%	4.7%	**4.0%**	5.6%
UK	4.2%	4.0%	**3.9%**	4.5%
US	5.2%	4.0%	**4.0%**	5.2%

The column presenting the empirical equity premium for the period 1970-2010 is highlighted, as these estimates correspond to the period analyzed in this paper, and will therefore be used later in the paper to test the validity of the results.

Firstly however, the following section will proceed to look at some of the most important approaches to finding a potential solution to the equity premium puzzle.

2.6 Possible explanation of the puzzle

The equity premium puzzle has received a lot of attention since the publication of the original study. Naturally, much attention has been aimed at solving the puzzle. This section reviews highlighted caveats and solutions to the puzzle, which can generally be sorted into two categories – approaches that focus on the data, and approaches focusing on the assumptions of the model of Mehra & Prescott (1985).

2.6.1 Data bias

Explanations that concern the data material primarily focus on ex-post bias in the data used by Mehra & Prescott (1985). Ex-post bias relates to the fact that equity premium analyses are done retrospectively.

By this nature, investors are implicitly given the attribute of perfect expectations/forecasting, in contrast to reality of investors who make their investment decision ex ante. Some have argued that the ex post bias can explain the over performance of equities. The argument is that ex post data sets include unexpected gain/losses, and in that way investors are not acting irrationally, but rather invested on the basis of existing knowledge at the time, and then afterwards experienced rewards on the investment that superseded what could have been forecasted.

Using this line of argument, Fama & French (2002) found that realized equity returns in the US in the period 1950-2002 were more than twice as high as traditional valuation models would have led investors to expect. Rietz (1988) has also argued that including even a low probability of a market collapse, can account for much of the over performance in US equity returns. Blanchard (1993), and Madsen & Dzhumashev (2009) argue that world wars, and the abandoning of the gold standard as monetary system, have lead to an elevated inflation, which investors could not have forecasted – leading to lower required rates of return, and in turn over-performance.

Finally, Jorion & Goetzmann (1999) proposed that data on equity returns overstates reality due to survivorship bias. Survivorship bias relates to the notion that equity indices measure return on companies that have survived, and thereby do not account for capital losses felt by investors from companies defaulting. While this argument makes good intuitive sense, Dimson, Marsh & Staunton (2008; 2011) showed that it only can explain a small part of the premium puzzle.

So while the data bias arguments have intuitive - and some quantitative - merits, none of them effectively disprove or solve the equity premium puzzle. Even when factoring in a 50 percent correction in equity returns suggested by Fama & French based on ex-ante vs. ex-post investor framing, the premium in the US “only” falls from approximately 6% to 3% - meaning that the premium is still much in excess of the explained estimate of 1.4%.

2.6.2 Model assumptions

As Mehra & Prescott’s puzzle cannot be solved convincingly on the basis of data bias, our attention is turned to approaches that look to the model assumption for an explanation. Again, these are generally divided into two groups – arguments that focus on the market assumptions, and arguments concerning the standard investor preference assumption.

As a standard model, the equity premium analysis by Mehra & Prescott (1985) assumed that capital markets are complete and that there are no transaction costs. Perfect capital markets enable individual investors to transact in order to balance a marginal rate of substitution across different economic states – diversifying risk of the utility. With complete capital markets, heterogeneous investors transact and can be argued to act homogenously on an aggregate level, thereby constituting a representative investor. The central point is, that if investors cannot be represented through such a general agent, but instead are faced with idiosyncratic risk, then per capita consumption cannot represent investor consumption. If investors are not diversified or "hedged" through capital markets, then the individual volatility in consumption would be higher than per capita data implies. Several authors have discussed the effect of relaxing this assumption (Weil, 1989; Tristani, 2009), and while it has been argued that this can provide some explanation to the large equity premium, there is substantial support for the conclusion that changing this assumption cannot fully solve the puzzle (Lucas D. J., 1994; Kocherlakota, 1996; Heaton & Lucas, 1996; Mehra, 2008).

Discussions regarding the assumption of no barriers to trading are quite parallel those on perfect markets. Assuming no transaction cost is obviously not realistic, but the question is to what extent changing the model on this account affects the results. Some authors argue that transaction cost can explain the premium puzzle (Aiyagari & Gertler, 1991; He & Modest, 1995) however these approaches require very high transaction costs. So the prevailing conclusion, as with perfect markets, is that relaxing the assumption of no barriers to trade does provide some explanation, but cannot fully solve the equity premium puzzle (Jang, Koo, Liu, & Loewenstein, 2007; Heaton & Lucas, 2007).

The last line of explanation approaches focus to the investor preference assumption of the model. This is also the area that has received the most attention, as well as being the approach that has shown the most promise in terms of reaching a potential solution. The following will review the most important developments on the subject, ending with a brief introduction to myopic loss aversion, the approach used in this paper, which falls under this general category, and will be discussed in detail in the second half of theory section.

Generalized Expected Utility: As mentioned earlier, Mehra & Prescott (1985) based their model on a standard preference assumption, which was based on the central feature that risk aversion is reciprocally related to the elasticity of intertemporal substitution of utility. This had the neat implication that investors, being risk averse, would seek to smooth the utility over economic cycles and over time. This however also had the counterintuitive implication that investors, given this smoothing desire, are assumingly opposed to growth in consumption. On this basis, scholars have looked at alternative preference structures as possible remedies.

Epstein and Zin (1989; 1991) developed an alternative approach called generalized expected utility (GEU), which separated the risk aversion coefficient from the elasticity expression, thereby allowing for investors to accept consumption growth, by limiting the utility smoothing to variation across economic cycles. The intuition is that investors approach assets through their relation to volatility in consumption, but also through their relation to total wealth – being the collective assets. In practice, this led to an asset pricing approach that combined the consumption based element known from the original theory, with a wealth component where the authors used the general stock market as the proxy. While Epstein & Zin claimed to have explained the puzzle in this way, other scholars have pointed to problems with the application to this approach. The central argument opposing this solution is that the equity market does not reflect the investor's total asset portfolio, meaning that the explanatory power of this relation is overestimated (Kocherlakota, 1996; Mehra & Prescott, 2003). Also, the GEU model still requires levels of risk aversion above what is imaginable (relative risk aversion coefficient larger than 45) to explain the premium puzzle, so the approach does not provide a convincing solution.

Habit formation: As with GEU, the habit formation approach also separates risk aversion from the elasticity of intertemporal substitution. The approach, first proposed by Constantinides (1990), builds on the idea that utility of consumption is related to the level of past consumption. Habit formation introduces a *momentary utility* element to capture that the utility from a certain level of consumption decreases overtime – the thrill of fine dining falls as it becomes an "everyday" event. This effect is then combined with a marginal utility function that increases with past consumption. This captures the notion that a high historical level of consumption will make a reduction more painful – a person who is used to luxury will experience large disutility from having to give up this lifestyle.

The habit formation model presented some strong intuitive improvements to the investor preferences, and Constantinides (1990) argued that it can effectively solve the equity premium puzzle. Generally, the method is however not seen as a solution, as it requires a very high risk aversion to even small decreases in consumption (Kocherlakota, 1996; Mehra & Prescott, 2003). While the high consumption risk can explain the savings motivation that fit with the low observed risk-free rate, the risk aversion needed is still above the reasonable levels, and the equity premium puzzle persists. Further work and debate has been done on approaches that follow this line of thinking, but it remains unknown whether it can provide substantial improvements.

"Keeping up with the Joneses": A third central approach to solving the equity premium puzzle was presented by Abel (1990). The approach was based on the relation between the individual's utility of consumption, and the broader average consumption of the community/society of the individual. The idea is that the marginal utility of the investor grows with general consumption in his community. Intuitively this means that the investor is primarily focused on keeping the relative status of consumption in society. In application this approach implied that investors are not necessarily highly risk averse towards their own consumption, but instead focused on the general level – meaning the per capita consumption. Under this view, investors will be particularly hesitant towards equity investments, as a potential fall in these will lead to a relative loss of consumption for him in comparison to his community. In effect, the approach faced the same problem as habit formation – it substituted one type of risk aversion with another, and hence did not solve the problem at hand overestimated (Kocherlakota, 1996; Mehra & Prescott, 2003). Some authors have developed and tested other approaches based on this line of argument (DeMarzo, Kaniel, & Kremer, 2004), but so far it has not brought about substantial headway towards a solution (Mehra, 2006).

Myopic Loss Aversion: First presented in the seminal article by Benartzi and Thaler in 1995, myopic loss aversion presents an alternative approach to solving the equity premium puzzle. Instead of using standard - or modifications of standard - investor preferences, myopic loss aversion is based on descriptive preference patterns from behavioral finance. Concretely, Benartzi & Thaler (1995) argued that the equity premium can be explained by the central concepts of loss aversion and mental accounting from behavioral finance. These are concepts that are based on experimental research of human decision making behavior, and therefore the myopic loss aversion approach is descriptive in nature in contrast to the normative approaches presented above.

Loss aversion, originally formulated by Tversky & Kahneman (1979), refers to how people experience more disutility from a loss of a given size, than the utility experienced from a gain equivalent in size. Mental accounting refers to the subjective framing steps that investors take subconsciously when investing (Thaler, 1999). The key feature is that people tend evaluate choices individually in separate mental accounts rather than on an aggregated level – focusing on equity investments individually rather than as part of a portfolio. This leads investors to experience more losses, as individual stocks move up and down, with higher volatility than the portfolio performance should imply. Consequently, equity investments require higher discounts than less volatile investments, as investors are more likely to experience drops that provide disutility. The effect is exacerbated by a tendency for investors to evaluate the investments very frequently, which increases the risk that equities are down despite the longer term positive mean return of the asset class (Thaler, Tversky, Kahneman, & Schwartz, 1997).

In sum, Benartzi & Thaler (1995) found that the balance between risky equities, and less risky investment alternatives, depended on the investment horizon of the investor. A short horizon would increase the chance of experiencing a loss on equities, to which the investor is averse, and hence lead to a high premium requirement. Meanwhile, a long horizon would even the fluctuation and loss bias, leading to a lower equity premium. In application Benartzi & Thaler (1995) found that the model could explain the observed equity premium in the US with an acceptable risk aversion and low risk-free rate, if investors evaluated their investments with a horizon of 12 months. They argued that such a horizon has intuitive appeal, as many investors have a natural yearly process of evaluation, based on tax and pension reporting, which occur yearly. The model also provided an estimate of optimal asset allocation, given the one-year horizon, of 30-55% to equities, which corresponded well with the observed investor allocation. In conclusion, Benartzi & Thaler (1995) provided an explanation of the equity premium in the US that fitted with the observed characteristics of low risk-free rates and smooth consumption growth. The rest of this paper will focus on this approach, and apply it to a broad number of European countries to investigate its general validity and potential as a broadly founded solution to the equity premium puzzle.

2.8 Chapter summary

In 1985, Mehra & Prescott tested whether the observed equity premium in the US from 1889 to 1978, could be explained by a consumption driven capital pricing model based on standard utility theory with rational agents. The conclusion was that the observed risk premium far exceeded the premium explained by the model. Even when using risk aversion coefficients substantially larger than empirical estimations, they found that the standard model could only account for 1.4% of the observed 6.18% premium, and in conclusion the authors labeled the finding as the equity premium puzzle. Following this publication, a number of studies have provided additional support for the finding. Kocherlakota (1996) used a different method to likewise show that risk aversion would have to be improbably high for traditional theory to explain the observed equity premium. Weil (1989) focused more specifically on the risk free rate element of the puzzle, and found that simply increasing the risk aversion could not solve the puzzle, as this would imply a risk free rate much larger than the historical level.

In 2006, Barro published an analysis of the equity premium puzzle in the G7 countries, highlighting a similar conclusion to that of Mehra & Prescott (1985). Other international research has focused on the observed equity premium, where Dimson, Marsh & Staunton (2008; 2011) have provided strong cross-country evidence of equity premia of magnitudes, which also imply existence of international puzzles.

Several attempts have been made to explain the equity premium puzzle. The proposals generally segregate into two groups, focusing on data biases and model assumption errors respectively. The most prevalent bias based explanation, focuses on the ex-post bias associated with the investors facing ex-ante decisions. Ex-post bias has been shown to explain as much as 50 percent of the premium, but has not effectively refuted the equity premium puzzle.

The model assumptions explanations also fall into two broads groups, focusing on market related assumptions, and the investor preference assumption, respectively. The market related attempts have shown that relaxing the perfect market conditionality, and adjusting for transaction costs, can explain part of the puzzle, but fail to provide a convincing solution. The investor preference approaches have generally appeared more successful. While the normative based attempts have so far failed to provide a convincing explanation, the descriptive and behavioral finance based myopic loss aversion approach presented by Benartzi & Thaler (1995), was shown to explain the US puzzle. The next section provides a more thorough overview of myopic loss aversion, and it's the theoretical basis, namely prospect theory.

3 Myopic Loss Aversion

As mentioned briefly above, myopic loss aversion is based on concepts from behavioral finance. Through application of this model, Benartzi & Thaler (1995) were able to provide a strong explanatory solution to the original premium puzzle in the US first observed by Mehra & Prescott (1985). This section presents the central theoretical foundations from behavioral finance on which myopic loss aversion is built, before describing the actual model in detail. Lastly, the validity of the approach is discussed through a review of the most central literature from the field.

3.1 Behavioral finance and standard preferences

As illustrated in the previous section, myopic loss aversion is an approach that differs from the standard preference structure assumed under traditional utility theory, and this is in fact the fundamental motivation behind behavioral finance as genre. Through the pioneering work of the cognitive psychologists Tversky & Kahneman (1979; 1992), it was shown that individuals do not act in a rational manner as stipulated by theory. The authors performed a number of behavioral experiments concerning the decision making processes of individuals. They showed that not only did people diverge from expected rational choices – they did so consistently in a manner that indicated systematic irrational choice patterns.

To illustrate the observed anomalies, consider the following experiment from Tversky & Kahneman (1981) where respondents were asked to choose between two options:

Tversky & Kahneman - Choice problem 1 - (N=86)

Option	Outcome	Probability	Choice distribution %
A	240 -760	0.25 0.75	[0]
B	250 -750	0.25 0.75	**[100]**

Option A has an expected utility of: $0.25 * 240 + 0.75 * (-760) = \mathbf{-510}$, while option B has an expected utility of: $0.25 * 250 + 0.75 * (-750) = \mathbf{-500}$.

As expected, all respondents choose B, which clearly dominates A. The participants were then faced with two new choices, assumed to be played out independently of one another:

Tversky & Kahneman - Choice problem 2 - Choice 1 - (N=150)

Option	Outcome	Probability	Choice distribution %
C	240 0	1.00 0.00	**[84]**
D	1,000 0	0.25 0.75	[16]

Tversky & Kahneman - Choice problem 2 - Choice 2 - (N=150)

Option	Outcome	Probability	Choice distribution %
E	-750 0	1.00 0.00	[13]
F	-1,000 0	0.75 0.25	**[87]**

Presented with these choices, the majority of the participants (73%) chose the combination C and F. The cumulative expected utility of the decision pairs are:

Option C,F = $[1.00 * 240 + 0.00 * 0] + [0.75 * (-1{,}000) + 0.25 * 0] = \mathbf{-510}$

Option D,E = $[0.25 * 1{,}000 + 0.75 * 0] + [1.00 * (-750) + 0.00 * 0] = \mathbf{-500}$

From these calculations it is clear that the preferred combination C,F is in fact equivalent to choice A in question 1, while the pair D,E equates to option B. As it was clear that B dominated A it is also clear that D,E dominates C,F, and hence that the majority of respondents showed irrational preferences thereby violating the standard rational preference assumption. Tversky & Kahneman (1979; 1981; 1992) performed a number of different experiments that showed empirical violations of expected utility theory. On the basis of this research, they developed a descriptive alternative called prospect theory.

3.2 Prospect theory

Prospect theory was originally developed and later extended by Tversky & Kahneman, in 1979 and 1992 respectively, and the theory presented a number of central differences in relation to conventional expected utility theory. With basis in the experiments performed, the authors described the decision process of individuals as a two stage process – with a framing and subsequently an evaluation phase. The framing phase is where an individual analyses the potential outcomes of the prospect at hand. In this process the individual assigns likelihoods and consequences of all potential outcomes of the overall prospect. As part of the framing phase, the individual determines a point of reference for the decision, which is later used to evaluate to the outcome against. The central finding of the authors was that this framing is in fact highly subjective and biased. This means for instance that the preference order of a specific set of prospects can differ based on the way the prospects are presented, as well as on the individual they are presented to.

The framing phase is followed by the evaluation phase where the expected value of the prospect is established. A central difference between the evaluation phase under prospect theory and that of traditional utility theory is that value is evaluated from *change effects* of a given prospect (delta), rather than the effect on absolute wealth. To catch these effects Tversky & Kahneman (1979) described the decision process as a combination of two functions – a value function and weighting function – that provide a prospective utility, used by the individual decision maker. The value function determines the value of potential prospects, while the weighting function describes the perceived probability of the individual outcomes of the prospect.

3.2.1 The value function

Tversky & Kahneman (1979) based their value function on three observed behavioral tendencies; reference dependence, loss aversion and diminishing sensitivity. Traditional utility theory assumes that utility is a concave function of wealth, meaning that as wealth increases, the marginal utility of the investor decreases. This implies that the utility of all decisions are evaluated with regard to their effect on aggregate wealth. Tversky & Kahneman found that people did not evaluate prospects in this manner. Instead, it was found that outcomes are evaluated on an isolated basis – meaning purely as a loss or a gain. They labeled this as the *isolation effect* and argued that utility should be defined on a relative basis, meaning as a change effect from a point of reference (Kahneman & Tversky, 1979). Consequently, the prospective value function has a central point of reference, dividing prospects between the realm of gains and losses respectively.

Another central element of traditional utility theory is risk aversion. From the experiments of Tversky & Kahneman (1979) it was found that risk aversion was only an accurate description of behavior, when individuals are faced with positive prospects – meaning that participants preferred a certain gain over a 50% chance of receiving double the amount. However, when posed with a decision between prospects within the negative domain, the majority of participants (68%) became risk seeking – preferring the 50%

chance of the larger loss over the certainty of losing only half. Bases on these observations, the authors proposed to replace the risk averse characteristic, with the concept of loss aversion.

In effect the prospective value function remains concave in the domain of gains as investors are risk averse when choosing amongst positive prospects, however as they become risk seeking when faced with negative prospects, the value function appears convex in the domain of losses.

The experiments also illustrated another central behavioral characteristic, namely that participants were disinclined to take on seemingly fair bets with a 50-50 chance of winning or losing for instance $100, a bet that essentially has an expected value of 0. Furthermore, this behavior intensified as the stake of the bet increased. This highlighted a very interesting behavioral bias. If the stakes of two fair 50-50 chance bets are denoted as x and y, where x is larger than y then this observation implies:

$$V(y, 0.5; -y, 0.5) > V(x, 0.5; -x, 0.5) \text{ or;}$$

$$v(y)*0.5+v(-y)*0.5 > v(x)*0.5+v(-x)*0.5$$

where V is the value of the prospect, and v represents the value of the individual outcomes underlying the prospect. By cancelling the probabilities on both sides, one gets:

$$v(y) + v(-y) > v(x) + v(-x)$$

subtracting v(-y) and v(-x) on both sides yields:

$$v(y) - v(-x) > v(x) - v(-y)$$

Setting y = 0 then yields:

$$-v(-x) > v(x)$$

This relationship shows that the disutility of a given loss (x) is larger than the utility from the similar gain. This is the essence of loss aversion and implies that the slope of the value function is steeper in the negative domain than in the positive domain, which leads to a kink at the point of reference.

The last feature of Tversky & Kahneman's (1979) value function is *diminishing sensitivity*, meaning that the utility effect of a specific nominal gain or loss decreases as the absolute size of that gain/loss increases. A majority of participants responded that they preferred the choice of A: a 25% chance of winning 4,000 and 25% chance of winning 2,000 to the choice B: a 25% chance of winning 6,000, so:

$$V(6{,}000, 0.25) < V(4{,}000, 0.25) + V(2{,}000, 0.25)$$

⇨ v(6,000) < v(4,000) + v(2,000)

On the contrary, when faced with the same odds for taking a loss, respondents preferred the prospect that offered a smaller probability of a larger loss over a large probability of a smaller loss, meaning that:

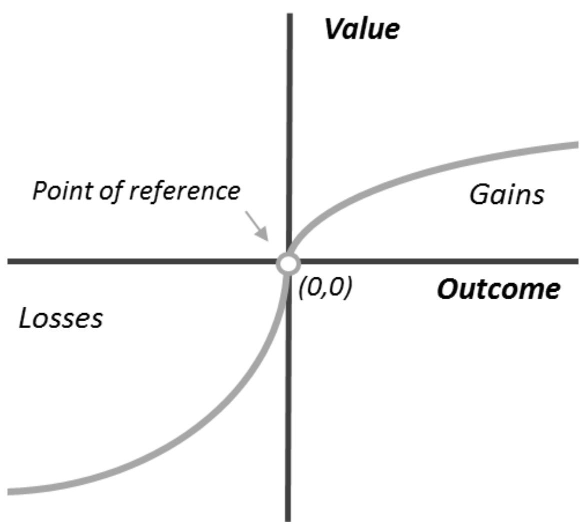
V(-6,000, 0.25) > V(-4,000, 0.25) + V(-2,000, 0.25)

⇨ v(-6,000) > v(-4,000) + v(-2,000)

The value of the large one-time loss is higher than the value of the two smaller losses combined, highlighting the diminishing sensitivity.

In sum, the value function of Tversky & Kahneman (1979) is characterized by 1) being centered around a point of reference from where any outcome is defined as a gain or a loss, 2) risk aversion behavior with regards to gains and risk seeking behavior with regards to losses, 3) loss aversion as losses are felt harder than comparable gains, illustrated by the steeper slope of the value function in the realm of losses, and 4) diminishing sensitivity as the impact of a gain or loss falls as the distance to the reference point increases, leading to the decreasing slopes in both domains (see Figure 3.1).

Figure 3.1 – Prospect theory value function



3.2.2 The weighting function

The other central component of prospect theory is focused on individuals' perception of probabilities of outcomes. Tversky & Kahneman (1979) found that people did not, as traditional theory suggested, evaluate based on the true probabilities, but rather transformed the probabilities subjectively. On this basis a weighting function was developed to capture this bias. The function essentially works to transform the true probability of a prospect *(p)* into a decision weight that matches the individual's perception of the outcome $\pi(p)$.

In contrast to traditional theory, experimental evidence showed that peoples' perceptions of prospects were biased from the true probabilities. Specifically, individuals exhibited diminishing sensitivity in assessing probabilities. This means that the effect of a probability change diminishes with its distance from the boundaries (impossibility and certainty), so the effect of a 10 percent point change in probability from 1 (certainty) to 0.9 for a given outcome, has a larger impact on the perceived value than a similar change from 0.5 to 0.4 in probability. This implies that the weighting function is concave around the impossibility corner and convex towards certainty (Tversky & Kahneman, 1992).

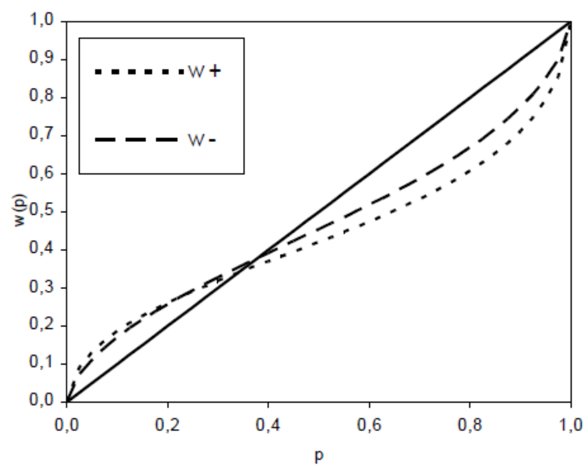
Another central observation was that participants generally overweigh small probabilities and understate high probabilities. This effect provides an intuitive explanation for the widespread participation in lotteries and insurance plans, which have negative (true) expected return. When approached rationally these "bets" represent large negative expected utility prospects, meaning that the cost of a lottery ticket is far above the cumulative payout multiplied by the true probability of winning. Yet people still willingly participate. The behavioral explanation is that people define probabilities in broader discrete boxes – such as likely, unlikely, very unlikely and extremely unlikely etc. While this works reasonably for more "tangible" probabilities ranges, it leads to biases in extreme cases. In the case of the lottery, people recognize that winning is extremely unlikely but fail to recognize just how unlikely. Cognitively, all prospects with a probability below some subjective limit e.g. 1:10,000 are deemed unlikely with the same emphasis even though there is far from 1:10,000 to the 1:8,347,680 chance of getting the 7 correct numbers in the Danish national lottery[3]. This framing effect leads to the general overstatement of small probabilities.

Lastly, experiments revealed that perception of probabilities was also different for gains and losses respectively. Participants were found to shift the risk-attitude depending on the probability. When faced with likely prospects ($p \geq 0.5$) respondents adhered to the loss aversion pattern of risk seeking behavior in the domain of losses, and risk averse behavior for gains. However when faced with small probabilities

[3] See Danskespil.dk/service/vinderchancer for details on calculation

(p ≤ 0.1) the pattern was reversed – people were risk averse for negative outcomes and risk seeking for positive outcomes. Based on these observations Tversky & Kahneman (1992) found that the weighting function follows what they called the *fourfold pattern of risk attitudes* - for small probabilities investors are risk seeking in the domain of gains and risk averse in the domain of losses, while for higher probabilities the pattern is reversed. As the weighting function therefore differed between gains and losses, the two functions are illustrated individually:

Figure 3.2 – Prospect theory weighting function



From the illustration (figure 3.2), the observed behavioral aspects are clearly visible, as the functions are concave around low probabilities and convex towards high probabilities. It is visible that low probabilities are overstated (the weight put on the outcome is higher than its true probability) and high probabilities are understated (the weighting function is below the true probability).

3.3.3 Technical formulations of prospect theory

Based on their research, Tversky & Kahneman (1979; 1992) were able to define the value function and weighting functions more formally, and then fit the observed behavior of respondents to those functions.

The value function with the characteristic S shape was defined technically as a two-part function:

$$\textbf{(3.1)} \qquad v(x) = \begin{cases} x^{a} & \text{if } x \geq 0 \\ -\lambda(-x)^{\beta} & \text{if } x < 0 \end{cases}$$

where *x* is the prospective outcome relative to the reference point – the gain or loss. The exponents α and β are both below 1 due to the diminishing sensitivity characteristic. Lambda is a constant that captures the loss aversion effect and therefore above 1, leaving the individual with larger disutility of a given loss than the prospective utility of the corresponding gain. Tversky & Kahneman (1992) estimated the coefficient based on their empirical research, and found the median of both alpha and beta to be 0.88, while lambda was estimated to be 2.25, signifying that a given loss is felt more than twice as hard as a gain of the same amount.

As the weighting function is cumulative, the individual perceive outcomes from their rank within the entire (cumulative) outcome range. In this way, an investor will perceive a given outcome based on the chance of receiving something that is at least as good along with the chance of receiving something that is better. So the decision weight of a gain is described as:

$$(\mathbf{3.2}) \qquad \pi_i^+ = w^+(p_i + \ldots + p_n) - w^+(p_{i+1} + \ldots + p_n)$$

Where the first term on the right hand side represents the case of getting something that is as good (i or gains that rank above it), and the last term represent outcomes ranking over (gains that are strictly higher). To simplify the expression, the probability terms can be summarized so the $p = (p_i + \ldots + p_n)$ and $p^* = (p_{i+1} + \ldots + p_n)$. This yields the term:

$$(\mathbf{3.3}) \qquad \pi_i^+ = w^+(p) - w^+(p^*)$$

Correspondingly, the decision weight of a negative outcome is described as:

$$(\mathbf{3.4}) \qquad \pi_i^- = w^-(p) - w^-(p^*)$$

Both the positive and the negative decision weights are conditioned by the extremes stating that w^+ (1) and $w^-(1)$ are equal to 1, and w^+ (0) and $w^-(0)$ are equal to 0 – where an outcome has no probability of occurring.

The next step is then to determine the capacities (w) in the equation. Tversky & Kahneman (1992) approximated the capacities as one-parameter expressions, based on experimental observations:

$$(\mathbf{3.5}\ \&\ \mathbf{3.6}) \qquad w^+(p) = \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{1/\gamma}} \qquad \text{and} \qquad w^-(p) = \frac{p^\delta}{(p^\delta + (1-p)^\delta)^{1/\delta}}$$

They found γ to be 0.61. This was later tested by Camerer & Ho who found γ to be 0.56, close to the original value (Camerer & Ho, 1994). For negative prospects Tversky & Kahneman (1992) found the exponential factor (δ) empirically to be 0.69. As visible from the weighting function (figure 3.2), this larger factor leads to less overestimation, both on the upside for low probabilities and on the downside for high probabilities.

Based on the value and weighting function the overall prospect utility term is termed:

$$\textbf{(3.7)} \qquad V = \sum_{i=-m}^{n} \pi_i v(x_i)$$

A simple example illustrates the mechanics and practical application more intuitively. Imagine an investor faced with prospect that has two possible outcomes; A 5% chance of gaining \$10, and alternatively a 95% chance of gaining \$2. First, the value function is applied to determine the value of each outcome. As both outcomes are in the positive domain the value function is $v(x) = x^a$, where a is 0.88. This yields $10^{0.88} = 7.59$ and $2^{0.88} = 1.84$ respectively.

The next step is to determine the weight associated to each of the outcomes. As both outcomes are positive, the weighting function is given by the difference in capacity of getting something that is equally good and something strictly better. In this simple example the case is quite straight forward as the gain of \$10 is the best outcome with no chance of getting something strictly better. This means that the decision weight for the gain 10 outcome is $\pi_i^+ = w^+(p)$ where p is 0.05. In turn, the decision weight is the capacity equal to:

$$\pi_i^+ = w^+(0.05) = \frac{0.05^{0.61}}{(0.05^{0.61}+(1-0.05)^{0.61})^{1/0.61}} = 0.132 \text{ or } 13.2\%$$

Turning to the second outcome, gaining \$2, which is the worst possible outcome in the simple example. Hence, the investor is 100 percent sure of getting something equally good or better which means that p = 1, and in turn by condition $w^+(1)$ = 1. The decision weight can now be determined as the difference in capacities:

$$\pi_j^+ = w^+(1) - w^+(0.05) = 1 - 0.132 = 0.868 \text{ or } 86.8\%$$

With all the components in place the prospective utility facing the investor can be computed:

$$V = (0.132 * 7.59) + (0.868 * 1.84) = 2.6$$

This is the formulation of prospect theory, which Benartzi & Thaler (1995) used in their myopic loss aversion study of the equity premium in the US. The remainder of the section will discuss the specific behavioral aspects behind the myopic loss aversion approach and review opposing literature.

3.3 Myopic loss aversion

Myopic loss aversion is a behavioral approach to decision processes focused on the combination of two specific concepts – loss aversion and mental accounting. Loss aversion, as described in the prior section, relates to the empirical observation that losses have more impact than corresponding gains, while mental accounting refers to the biased grouping of prospects that people subconsciously perform. To understand how the combination of these concepts affects the decision process a brief presentation of mental accounting is required.

3.3.1 Mental accounting

Mental accounting describes the way people group and evaluate financial activities mentally (Thaler, 1999). By placing a given prospect in a specific mental account, the individual implicitly determines the frame in which the outcome is evaluated. The intuition is that when people are faced with a large number of choices they subconsciously group them into brackets to make decisions easier – a process called *choice bracketing.* In this terminology, evaluating all decisions collectively on one aggregated level is consistent with *broad bracketing* and a requirement under traditional expected utility theory where the utility maximizing person makes decisions based on their aggregate effect on overall wealth. Alternatively, grouping choices in multiple brackets is termed as narrow bracketing, and it means that a prospect is evaluated only within its mental account, and not in terms of the overall picture. By narrowing the framing, an individual is at risk of making sub-optimal decisions as he fails to take into account the aggregate effects (Read, Loewenstein, & Rabin, 1999).

The intuition is highlighted by the example presented by Read, Loewenstein and Rabin (1999). They argue that the decision of smoking just one (the next) cigarette has only very limited consequences for a person's health and can therefore appear to make sense if there is substantial utility gained from the decision. However, when approaching the decision to smoke on an overall level, cigarettes are largely damaging and likely to shorten the person's life expectancy, making the decision to smoke more irrational. The smoker focuses on the mental account and narrow bracket when making the individual decisions on whether to smoke the next cigarette, and in doing so he fails to ever take into account the big picture effect. Empirically the inability of people to rationally evaluate prospects from an overall perspective was highlighted by Tversky & Kahneman (1981) in their 'Choice problem 2' decisions presented in section 3.1, where people failed to see the combined effect of choice 1 and 2, leading a majority of respondents to choosing sub-optimally. This narrow bracketing and nearsightedness is what is also referred to myopia.

The concept of choice bracketing and mental accounting has a central role in behavioral finance, where the frequency of the investment evaluation is determined by the extent of narrowing bracketing employed. As investors evaluate their investment, they mentally reset their reference point, which in turn determines whether the development since the last evaluation constitutes a loss or a gain (Thaler, 1999). Based on this perspective Benartzi & Thaler (1995) argued that the risk attitude and decision process of investors are related to the frequency of evaluation – or the investment horizon.

3.3.2 Mental accounting and loss aversion in combination

Benartzi & Thaler (1995) proposed an explanatory approach to solving the US equity premium puzzle, based on the use of prospect theory preferences. They argued that the historic over performance of equities in comparison to risk-free investments could be accounted for by loss averse investors who evaluated their investment portfolio in a short-sighted manner. The intuition was that investors "suffering" from narrow bracketing – myopia - would tend to look at their investment returns individually rather than on more aggregated levels (longer horizons). By doing so, the aversion to losses would lead them to require very high premiums in order to accept the riskiness of equities in comparison to the risk-free investment alternative, which provided little to no risk of observing a loss.

The combination of myopia and loss aversion was already illustrated in 1963 by Samuelson, who experienced the notion in conversation with a colleague (Samuelson, 1963). He famously offered the colleague a 50-50 chance of yielding either a gain of \$200 or a loss of \$100, to which the colleague refused saying that he would feel the loss of the \$100 more than the potential gain of \$200. He would however accept the bet if he was promised 100 repetitions. The intuition behind this behavior is visible from the simple myopic loss aversion example Samuelson presented. Imagine the utility function with a loss aversion coefficient of 2.5:

$$U(x) = \begin{cases} 2.5x, & x < 0 \\ x, & x \geq 0 \end{cases}$$

Where x describes the change in wealth from point of reference, hence a specific change is felt 2.5 times more in the loss domain compared to gain domain. Given this preference structure, the initial bet would yield a negative prospective utility:

$$[0.5 * \$200] + [2.5 * 0.5 * -\$100] = -\$25$$

Now consider instead if the bet is considered in conjunction with a repetition. This would lead the colleague with a 25 percent chance to win $400 (two wins), a 50 percent chance to win $100 (a win and a loss) and 25 percent chance of losing $200 given two losses. His aggregated utility in that case would be:

$$[0.25 * \$400] + [0.50 * \$100] + [2.5 * 0.5 * -\$200] = \$25$$

It is evident that by escaping the narrow framing of evaluating the bet on an individual basis the prospect utility changes with increasing risk willingness. This was the driving force behind Benartzi & Thaler's (1995) proposed solution to the equity premium puzzle.

Translated to their approach, myopic loss aversion meant that investor's utility from different assets classes with different volatilities depend on their subconscious investment horizon. While stocks on average have delivered a higher return than risk-free investments, they have done so with a much higher volatility. The high volatility means that investors with frequent evaluations will be more likely to experience losses to which they are adverse – meaning that their utility of stock investments is low. In contrast, investors who are less myopic re-evaluate their investments less often, and hence experience returns closer to the mean values of the assets classes, lowering the chance of experiencing the aggravating losses. Consequently, the required premium for investing in equities is determined by investors' aversion to losses, along with their inherent evaluation horizon.

3.3.3 Empirical findings of Benartzi & Thaler

Benartzi & Thaler (1995) applied their model to monthly returns on stocks, bonds and bills in the US over the period 1926-1990. In essence, the aim of the analysis was to find what implied investment horizon would explain the observed equity premium. In addition, they also investigated the implied optimal asset allocation for investors, and the effect on the equity premium from extending the investment horizon.

In application, the approach was to calculate the prospective utility from holding a pure portfolio of each asset – bills, bonds and equities respectively. They then extended the horizon starting with 1 month to longer periods in order to see what horizon would yield the same prospective utility across assets – meaning the horizon where investors would be indifferent between holding the different assets. They performed the analysis on both nominal and real returns. They argued however that nominal is the appropriate return to use based on two arguments. Firstly, as the theoretical base, prospect theory, was a descriptive theory, the returns used in the analysis should match those that the investor faces in the decision process, and as most investment material exists in nominal terms, this best reflected the investor's experience. Secondly, they found that the prospect utility of holding bills was negative in real terms. As negative utility investments would not make sense, this implied that investors were looking at nominal returns, since Treasury Bills were in fact being traded (Benartzi & Thaler, 1995). Table 3.1 shows the results of both their nominal and real analysis:

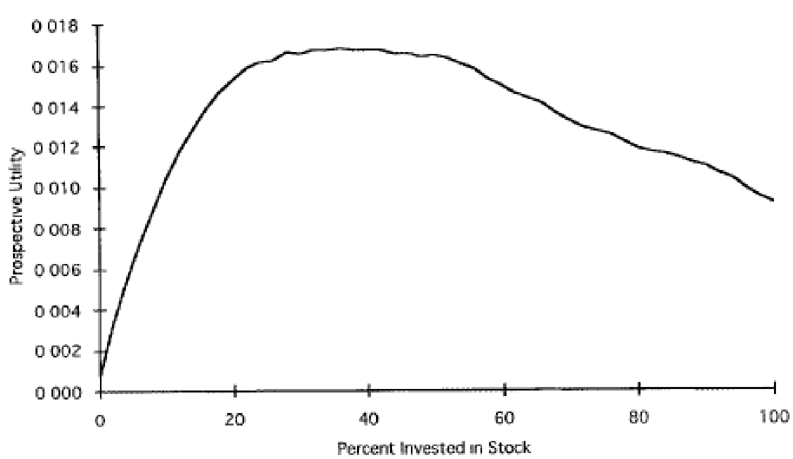
Table 3.1 Benartzi & Thaler - Emperical findings

Premium analysis	Nominal returns	Real returns
Stocks return premium over Treasury bills	12 months	9-10 months

The implied investment horizon that would explain the equity premium was found to be approximately 12 months, while the period was found to be 13 months for bonds. The shorter implied horizons for real returns highlight the appearance of a downside risk from inflation on the fixed income investments in real terms. Benartzi & Thaler (1995) argued that a 12-month horizon was realistic as this coincided with the typical pattern of investment formalities such a tax fillings, and mutual and pension fund return reports.

Based on this estimate of the investment horizon, the authors turned to estimating the optimal asset allocation. The intuition was that if the investment horizon was approximately one year, then the observed asset allocation should match the combination yielding the highest prospective utility. To calculate the utility maximizing allocation they fixed the investment horizon to 12 months, and then calculated the prospect utility for all combinations stretching from the extreme no equities, to a portfolio only consisting of equities. The results are illustrated in figure 3.3:

Figure 3.3 – Prospect utility and asset allocation



Benartzi & Thaler (1995) consequently found that the optimal allocation, given a 12-month investment horizon, would consist of 30-55 percent of shares. They reported that institutional investors on average allocated 53 percent to shares, and hence argued that this further supported the 12-month investment horizon finding.

Lastly, the authors calculated the implied equity premium for different investment horizons. The approach was to add/subtract a constant factor (a premium/discount) to all observed bond returns, and then solve for the value of this factor that would leave investors indifferent between the prospect of bond and equity investments. The compounded return of the equity investment, and the adjusted bond return were then calculated and the difference found was the implied premium. Table 3.2 shows the findings for implied premia:

Table 3.2 - Implied equity premium findings

Evaluation horizon	Implied equity premium
1 year	6.5%
2 years	4.7%
5 years	3.0%
10 years	2.0%
20 years	1.4%

For the one year horizon the implied premium was found to be 6.5 percent. This was then compared to the observed premium by Mehra & Prescott (1985) of approximately 6.2 percent with the conclusion that myopic loss aversion provided a strong approach to solving the equity premium puzzle. Also, it was noted how the implied premium fell as the horizon was increased, which fitted well with the theoretical expectation that extending the horizon would lead to a lower required premium from investing in stocks.

3.3.4 Other empirical findings

Since the publication of Benartzi & Thaler's study in 1995 other studies have built on the approach by investigating myopic loss aversion empirically. One of the most important studies was published by Gneezy & Potters in 1997. In the study the authors showed how changes in the framing of bets changed the participants' betting behavior. They did so through experiments where participants were divided in two groups. The experiment showed that individuals, when faced with subsequent bets, significantly changed their behavior depending on how often they were allowed to evaluate their results. In support of myopic loss aversion, the group that was allowed to re-evaluate their results and stakes after each round, bet significantly lower amounts than the group, which was restricted to fewer evaluations

(Gneezy & Potters, 1997). This finding has also been supported by Thaler, Tversky, Kahneman & Schwartz who also performed an experiment focusing on frequency of evaluation, and likewise found a significant increase in risk willingness amongst participants with lower choice and evaluation frequency (Thaler, Tversky, Kahneman, & Schwartz, 1997).

Kliger & Levit (2009) published a study aimed at testing the validity myopic loss aversion outside the US. They utilized a specific feature of the Tel Aviv stock exchange to test the hypothesis, namely the feature that illiquid stocks can be switched to be traded only once a week instead of on a daily basis. The authors argued that this implicitly imposes a frequency restriction for investors which, if myopic loss aversion was to hold, would mean that investors would require lower returns on these weekly traded stocks. The finding was that weekly traded stocks did indeed have a lower return, and the authors hence concluded that this supported the theory of myopic loss aversion. While this study provides a rare international perspective in the literature, it is difficult to assess the actual implications, as it focuses on one specific market with idiosyncratic trading rules. Hence, there remains a large void in the literature testing the theory on a broader international and comparable scale, which is the aim of this paper.

In addition to these studies, it is worth noting that Læssøe & Diernisse in 2011 performed an analysis of the equity premium puzzle and myopic loss aversion in Sweden. Through a comprehensive study, the authors showed that myopic loss aversion provided a strong explanation to the observed premium puzzle in Sweden (Læssøe & Diernisse, 2011).

3.4 Critique of myopic loss aversion

The critique of myopic loss aversion can be broadly summed into three categories respectively focusing on; institutional investors, disappointment aversion, and the role of consumption. The first caveat regarding institutional investors was proposed by Locke & Mann (2005), who argued that these investors are inclined to exhibit less loss aversion than private investors, as they are not personally hit by the loss. The authors argued that frameworks that focus on private investors are flawed, as capital markets are largely driven by professional investors in pension, mutual and hedge funds who are investing on behalf of others. Benartzi & Thaler (1995) however argued that the short term incentive schemes prevalent in the contracts of investment professionals meant that short term losses overshadowed long term gains, and hence led exactly to myopic loss aversion behavior. This is a point that has received strong attention in the regulatory debate following the recent financial crisis, where regulators have put special emphasis on tying the incentive schemes of investment professionals to the long term performance, rather than the previous shorter term schemes. The myopic behavior of professional investors was further supported by Eriksen & Kvaløy (2010) who showed that managers investing other people's money exhibited alignment of interest with their clients even without incentive schemes to ensure pay-off alignment.

Another caveat to the myopic loss aversion approach was proposed by Ang, Bekaert & Liu (2005) who pointed to a different behavioral driver to explain the equity premium puzzle. While keeping a most of the Benartzi & Thaler model constant, they proposed one central change – namely that investors where driven by disappointment aversion rather than loss aversion. Instead of using the asset position as a reference point for evaluation they proposed that the investor measures return against the certainty equivalent alternative, meaning the certain outcome that the investor would accept instead of the risky investment. In this sense, the investor experiences utility from gaining more than the certainty benchmark, while he would be *disappointed* to see outcomes below. As the certainty equivalent outcome changes over time, the initial reference point was argued to become irrelevant. Based on this the Ang, Bekaert & Liu (2005) argued that the focus on the investment horizon in the myopic loss aversion model is misplaced and would leave it invalid over longer horizons.

Fielding and Stracca (2007) investigated this critique with specific focus on the influence and explanatory power of the investment horizon. Through application of the two models, they found that myopic loss aversion provided the superior explanation for investment horizons spanning until 10 years, after which the disappointment aversion model gains favor. The conclusion was that the models where not mutually exclusive and might both play a role in explaining the historical puzzle. However, as there is no existing experimental evidence to support the disappointment aversion behavior, I argue that the disappointment approach represents an interesting perspective, but that the myopic loss aversion approach remains more relevant due to stronger empirical backing.

The third critical perspective concerns the role of consumption, and was brought forth by Barberis, Huang & Santos (2001). They argued that the weakness of Benartzi & Thaler's model was the sole focus on utility from financial investments, and the consequent disregard of consumption and total wealth. Instead they argued that a realistic model should align with the classical approach – the consumption based CAPM – in keeping consumption as a factor in the model. In application, they proposed a model where the narrow framing was related to aggregate consumption. They found that their model could explain the high premium even with smooth consumption growth (Barberis, Huang, & Santos, 2001). In 2008 however, Barberis & Huang themselves argued that their consumption based approach was flawed as the dynamic framing component related to consumption was based on assumptions that were not supported by experimental evidence (Barberis & Huang, 2008). As with disappointment aversion the inclusion of a consumption component to the myopic loss aversion framework presents an interesting perspective for future research, but is not yet validated to the point where it offers a more convincing approach to equity premium analysis.

In conclusion, there has been some critique of the original Benartzi & Thaler model since it was published in 1995. All of these have pointed to interesting assumptions and potential caveats of the model, but none have convincingly disproved the original approach nor have they presented a superior alternative. On this basis I have stuck to the original model in this study, and instead focus on the implications and validity of the original model when applied to a comparative sample of European countries.

3.5 Chapter Summary

The myopic loss aversion model applied by Benartzi & Thaler (1995) presented an alternative to the standard preference structure from utility theory. The model was based on prospect theory preferences originating from the pioneering work of Tversky & Kahneman (1979; 1992), who through behavioral experiments showed that people do not adhere to the suggested behavior of standard utility theory. The authors proposed that the utility of a prospect is given by two functions – a value a function and weighting function. The value function is characterized by the three principles of reference dependence, loss aversion, and diminishing sensitivity. The weighting function is likewise structured to mirror the asymmetry in risk behavior, with people seeing risk when considering negative prospects, while being adverse to risk in cases with gains. The asymmetry was also shown to be reflected in the probability that people assign to potential outcomes, where a general tendency was overestimation of small probabilities.

Building on the preferences of prospect theory, myopic loss aversion is constructed by two concepts – mental accounting and loss aversion. These specifically relate to the effect of investors evaluating each investment in separate mental accounts, while failing to evaluate investment returns on an aggregated level. With frequent evaluations investors holding volatile assets experience more frequent losses to which they are adverse. Consequently, the assets yield a lower utility, leading to higher required premium compensation.

Using this model Benartzi & Thaler (1995) showed that the observed equity premium in the US over the period 1926-1990 could be explained by investors being loss adverse and evaluating their portfolios roughly once a year. The horizon was found to be fitting based on the typical reporting cycle to tax authorities etc. and it was further supported by the implied optimal asset allocation observed in the US. Other empirical work has supported the validity of myopic loss aversion both in US and elsewhere, but the amount of research is scarce.

Critical perspectives to myopic loss aversion have appeared since the publication. The critique has been focused on the investor characteristic in the model as well as on alternative aversion patterns as decision drivers, but has not convincingly disproved the approach as a solution to the puzzle. The next section presents the comparative empirical analysis and results of this thesis.

4 Data

As this study is a comparative analysis of equity premia and myopic loss aversion across different European countries, the empirical analysis is based on a large quantity of data from multiple sources (see appendix D). This section presents the data used as well as the key characteristics of the data. The section is structured into three components; firstly the overall approach to data collection is presented. Secondly the individual data components are presented for each of the countries analyzed. Lastly, key characteristics of the data are presented and discussed in relation to the analysis.

4.1 Guiding principles in data collection

In the original study of the US equity premium puzzle Mehra & Prescott (1985) used five different data series – equity return data, bond return data, bill return data, inflation data and consumption data – all of which were used in a yearly format, covering the period 1889-1978. In their analysis of myopic loss aversion, Benartzi & Thaler (1995) used the same data, with the exception of the consumption series, over the period 1926-1990, but on a monthly basis. A key challenge related to applying these frameworks on multiple European countries is that high quality data is not easily available for most countries. This is highlighted by Dimson, March & Staunton (2011) in their international study of equity premia. They refer to a collaboration with more than 150 individual authors as basis for their 19 country dataset[4] covering the period 1900-2011. A main reason behind the comprehensiveness of the data gathering process is that available historic equity data only stretches approximately 40 years back in time. Beyond this time frame the data material depends on what existing research has been done by economists in the respective countries. However, even if this was feasible, it would as shown by Dimson, Marsh & Staunton (2011) only provide yearly data for the older periods, which would only help the equity premium analysis and not the myopic loss aversion element, which requires monthly data. Based on this, there are two general guiding principles to data collection in this analysis. These are presented along with the data considerations for the primary data categories in the following subsections.

[4] The DMS database is license protected and distributed by Morning Star Inc. Guidelines and information regarding subscription can be found at www.tinyurl.com/DMSsourcebook

4.1.1 Timeframe

The analysis in this study is restricted to the period from 1970-2010. This is aligned with the beginning of the available total equity return data series in the countries analyzed, which enables calculation of monthly return data on equity investments. This in effect lowers the time frame of both analyses, and it limits the observations. Especially the equity premium analysis, which in the Mehra & Prescott format used yearly data, would then only yield 40 observations. Based on this I have used quarterly data for the first part of the analysis, which provides 160 observations well in line with the existing empirical studies[5]. The reason for using quarterly and not monthly data is that the equity premium analysis requires consumption data. This is part of GDP data for countries, which is published quarterly, and hence does not exist on a monthly basis.

In conclusion, the data used in this analysis covers the period 1970-2010. For analysis on country equity premia, the data is collected in a quarterly format, while for the myopic loss aversion the more frequent monthly data is used. It is important to note that the data is the same for both parts of the analysis, as the quarterly data used in the first part is simply specific extracts from the underlying monthly data series on risky and risk-free asset returns and consumer price indices.

4.1.2 Consistent methodology

In order to the have the best basis for comparison across the different countries, a guiding principle in the data gathering process has been to use consistent data sources where possible as the data series for different countries then share methodology. On this basis the input data is primarily gathered from international sources, as these sources provide more comparable data series for multiple countries in the analysis. The primary sources are therefore the IMF, and MSCI accessed through Bloomberg.

4.1.3 Equity return data

For all the countries in the study I use the MSCI total return indices in local currencies as equity return data. The issue with equity performance is that dividend payments represent a significant share of returns for investors and these are not included in traditional stock price indices. This means that regular stock price indices will underestimate the actual performance. To correct for this, indices exist where the

[5] Mehra & Prescott (1985): 89 observations, Dimson, Marsh & Staunton (2011): 111 observations

dividends are included, which are labeled as total return indices. The MSCI total return indices begin in 1969 with monthly data providing a 40 year horizon for analysis[6].

The MSCI indices are capital weighted, but are not all-share indices. This creates a risk of selection and size bias – stock performances estimates may be skewed because the companies represented in a particular index out or underperform the entire market. The MSCI data exists in a Gross and a Net total return index. The data used in this analysis is the Gross total return Index, which in contrast to the Net Index does not take tax effects into account. The reasoning behind using the Gross Index is twofold. Firstly, Tax rates differ across countries and investors, making comparisons difficult. Secondly, equity returns are in this analysis measured relative to fixed income investments and these are not corrected for interest or capital gains taxation, so an adjustment on equities would lead to a bias in the comparative analysis. This method is in line with the approach used by Dimson, Marsh & Staunton (2008) in their equity premium database.

4.1.4 Risk-free return data

Estimation of riskless return data is by far the most comprehensive data process in the analysis, due to diversity in quality and availability of sources in the different countries. While the individual data sources are described for each country in the specific data section, there are comments worth noting that apply to the general principles of data gathering. The concept of a "risk-free rate" is generally a source of debate and more so during this ongoing financial crisis than ever. This was highlighted recently by Financial Times columnist Gillian Tett who pointed to the fact that the price of insuring US debt (in CDS markets) this year, has been higher than the corresponding cost of insuring the company debt in the 70 most secure US firms (Tett, 2011). The lower insurance cost signals that these firms individually are less probable to default on their debt than the US as a country. This underlines how credit risk is increasingly a part of sovereign debt markets, which in turn could be argued not to be risk-free. Still, this paper

[6] Individual country studies regarding total equity returns stretching further back in time do exist. This is highlighted in the impressive work by Frennberg & Hansson in Sweden (1992) who provide total return series and equities and bonds in Sweden all the way to back to 1919 on a monthly basis. However, as these are the result of individual research projects they are not consistently available across the sample countries. Even if individual country research had existed with available data it is likely that the individual authors would have used differing methods in their work which would make comparative conclusions less valid.

follows the general tendency in finance and the approach of the original studies investigated in using short term government debt as a risk free asset. These bills remain the best broadly available option for people looking to investment money without risk. The typical instrument used is short term Treasury Bills (1 or 3 months papers) (Mehra & Prescott, 1985; Kocherlakota, 1996). Alternatively, other short term interest rates are used as proxies (e.g. 3-month interbank rates).

This analysis applies the general approach from Dimson, Marsh and Staunton (2008), where data is ranked and used in prioritized order determined by availability. In this way the risk free data series' are constructed from ranked input sources, where 3M Treasury Bill yields are ranked as highest quality, interbank rates as the best alternative, and central bank rates as the source of last resort. As the quality of risk free data from large international data sources with multiple country data is very varying, the primary data is sourced directly from the national central banks where possible. Other sources are then used where it is needed, and these are validated against the available central bank data. As the historical data series on risk free rates only exist in annualized yield format, these are converted to monthly returns by dividing the reported yield by 12 and then a total return index is calculated manually[7].

4.2 Specific country data

To provide the best possible transparency given the many different inputs used, the following section provides an overview of the data sources used for each individual country in the analysis. The countries' data sets share sources on most accounts. As described above, all equity return data is drawn from the MSCI series. The private consumption data is drawn from the OECD statistics data base, in the nominal quarterly format that exists as a subcomponent of the country GDP reports. To obtain the per capita consumption used in the equity premium analysis, the consumption series is divided by population. The population data series is also drawn from the IMF. As the data input used in the analysis is real consumption growth, the per capita consumption is adjusted for inflation. The inflation data is generally drawn from the IMF consumer price indices (CPI), with the exception of Germany as described in the relevant subsection. The risk free return data is constructed individually based on the data availability

[7] As the analysis focuses only on the very short-term bonds as the risk free rate, there is no correction for price change effects in the return calculation. This methodology follows the approach of Frennberg & Hansson in their extensive analysis of financial returns in Sweden (Frennberg & Hansson, 1992).

following the priorities described above. As these are unique for each country they are presented individually.

4.2.1 Belgium

The equity return, consumption, and inflation data follow the general sourcing. The risk free rate return index is constructed from the National Bank of Belgium's official 3 month Treasury bill yield data from 1991 where the series begins to 2010. Between 1969 and 1991 the risk free return is based on Belgium treasury rate series from the IMF drawn from Bloomberg. To validate the IMF series it has been analyzed against the overlapping period where data exists from both sources. The analysis shows that the average difference is 0.04% per month, and the correlation between the two series is 0.998.

4.2.2 Denmark

The equity return, consumption, and inflation data follow the general sourcing. The risk free rate is based on the 3 month Treasury bill rate drawn from the Danish central bank from 1989, where the series begin, to 2010. Between 1972 and 1989 the risk free rate is the 3 month Treasury bill rate drawn from Ecowin. For the brief beginning period from December 1969 to 1972, the risk free rate is based on the central bank rate drawn from the IMF, as no treasury data exists for the period. To validate the 3 month treasury data series that extend on the National bank data, the overlapping period has been analyzed. The two series match closely, with an average monthly difference of 0.06% over the period and a correlation 0.988.

4.2.3 France

The equity return, consumption, and inflation data follow the general sourcing. The risk free return is based on the 3 month Treasury bill rate from the French National Bank from 1993, where the series begins, to 2010. Prior to that, the IMF 3 month treasury rate data is used. The IMF series begins in January 1970, so the central bank rate from the IMF is used for the one missing data point in December 1969. The central bank and the IMF series match very closely, as the average difference is 0.001 percent and the correlation over the comparable period is 0.999.

4.2.4 Germany

The equity return and consumption follow the general sourcing. The inflation series has been constructed as the consumer price index data series currently produced by both the IMF, as the German Bureau of Statistics (Statistischen Bundesamtes Deutchland) only dates back to the reunification of Germany from 1991. The CPI series for West Germany, drawn from the German bureau of Statistics, is therefore used for the period before 1991. The risk free return is based on German 3M treasury yields from Bloomberg from May 1993, where the series begins, to 2010. Prior to that, the risk free return is based on the Ecowin 3 month treasury rate data series, which begins in 1975. From 1969 to 1975, the basis is the OECD 3 month money market data series, drawn from Bloomberg. To validate the Ecowin data stretching back to 1975, the series has been analyzed against the observed Bloomberg data in the overlapping period. The two series match well with an average difference of 0.14 percent and a correlation of 0.994. Testing the OECD data series against the observed Bloomberg series in a similar manor, yields a less convincing average difference of 0.3% and a correlation of only 0.955. This however, should does not disqualify the usage of the data, as much of the divergence is related to the most recent period, which is furthest from the time span where the data is actually used. When comparing instead the period from 1995 to 2006, before the financial crisis, the result is an average difference of 0.17% and a correlation 0.993, highlighting a much better fit[8].

4.2.5 Netherlands

The equity return, consumption, and inflation data follow the general sourcing. The risk free rate is constructed from a number of sources, as the short-term bond data for the Netherlands is not strong historically. For the most recent period, the rate is based on the observed 3 month treasury yields in Bloomberg. The series cover the period from 2001 to 2010. Extending on this, the OECD money market data series drawn from Bloomberg is used. This covers the period from 1986 to 2001. Going further back, the risk free rate is based on the IMF treasury yield data series, which runs from 1980 with monthly data[9]. Prior to 1980 there is no available Treasury bill data, and therefore the IMF central bank rate is used as basis in the period from 1969 to 1980. To validate, the OECD money market data series has been analyzed against the Bloomberg 3 month Treasury bill series over the overlapping period. The correlation between the two is 0.923 and the mean difference is 0.4%, which is not a strong fit, however as with

[8] The reason behind the diminishing coherence over the recent crisis is that the crisis was largely a banking crisis. As the financial sector was shocked, the interbank market froze, leading to a spike in interbank rates. Meanwhile, investors “fled to safety” in core government bond such as German debt. Hence the two rates – government and interbank rates – spread widely apart and broke the strong historic coherent relationship. Based on these effects, usage of interbank rates should in general be avoided as proxy for risk free rates over the latest period.

[9] The IMF Treasury bill series only exists between 1980 and 1990, which is why it is used as the 3. priority data source after the OECD money market series, which continues until the Bloomberg pricing begins in 2001.

Germany the divergence is driven by the recent split between sovereign and money market rates. When comparing instead the overlapping period until the end of 2006, the analysis shows a stronger correlation of 0,986 and an average difference of 0.16% on the monthly basis.

4.2.6 Norway

The equity, consumption and inflation data follow the general sourcing. The risk free rate is based on 3 month Treasury bill yield data from the Norwegian central bank from March 1985, where the series begins, to 2010. Extending on this, the risk free rate is based on the Ecowin 3 month interbank rate series beginning in August 1971. The risk free rate, prior to August 1971 is based on the central bank rate from the Norwegian central bank. To validate the Ecowin interbank data series, it is analyzed against the treasury yields data from the central bank across the overlapping period. Over the entire period from March 1985 to 2010, the correlation is 0.968 and the average difference is 0.26%. This comparison indicates a weak match, but should however be interpreted carefully. While affected, as Germany and Netherlands, by the recent crisis, the Norwegian case has another major divergence driver that should be accounted for. As a close neighbor to Sweden, the Norwegian financial market is affected by developments in Sweden. This is especially visible in the data concerning the last half of 1992, where there was an isolated Swedish banking crisis. From September to December in 1992, the average spread between the Norwegian 3 month treasury rate and the interbank rate was 8.2%, as the interbank market froze due to the Swedish crisis. Removing this special event from the comparison period shows a very strong general relationship, with a correlation of 0.995 and an average monthly difference of 0.12%. Therefore I feel comfortable using the interbank rate as proxy from 1971 to 1985, as the period is prior to the Swedish banking crisis effect in 1992.

4.2.7 Sweden

The equity return, consumption, and inflation data follow the general sourcing. The risk free rate in the period 1983 to 2010 is based on the 3 month treasury rate from the Swedish central bank. Extending on this, the risk free rate between 1969 and 1983 is based on the Ecowin 3 month treasury rate series. To validate the Ecowin data, the two series have been analyzed across the overlapping period. The two series are nearly perfectly similar over the shared period, with a correlation of 0.9999 and an average monthly difference of 0.004%.

4.2.8 Switzerland

The equity return, consumption, and inflation data follow the general sourcing. The risk free rate is based on the 3 month Treasury rate sourced from the Swiss National Bank (SNB) in the period from 1980 to 2010. In the period between 1974 and 1980, the rate is based on the Swiss interbank rate sourced from the SNB. Prior to 1974, the risk free rate is based on the central bank rate, as neither the Treasury bill nor interbank rate is available. Comparing the interbank data to the treasury rate shows a correlation of 0.988, and an average difference of 0.36%. This signifies a notable historic spread between the government and interbank rates. This is due to the special position of Switzerland, and particularly Swiss confederation bonds in the global economy, as the investment product and currency where investors seek security during turmoil. The renewed financial turmoil over the summer of 2011 highlighted this tendency, as Swiss treasury rates have traded below 0% yields, implying that people are paying money to be invested in Switzerland.

4.2.9 UK

The consumption and inflation data follow the general sourcing. The risk free rate is based on 3 month Treasury bill rates from the Bank of England in the period from 1975, where the series begins, to 2010. Prior to this the risk free rate is based on the 3 month Treasury bill rate from the IMF. To validate the IMF series, it has been analyzed against the Bank of England data over the overlapping period. The two series are nearly perfectly matched with a correlation of 0.998 and a mean difference of 0.007%.

4.3 Autocorrelation analysis

As the empirical analysis is generally based on historical financial data, no steps are taken to adjust for outlier observations. The underlying reasoning is that the "extreme events" that have occurred over the last 40 years, including the recent financial crisis, by nature have been events faced by investors. Hence, any adjustments to the data based on deviations from "normality" would instead corrupt the validity of the empirical analysis. The limited amount of historical data does however present an analytical constraint, specifically related to equity returns as will be discussed in the next section, and based on this, sensitivity analyses are made with simulated return data providing larger data foundations. The equity data has been analyzed with regards to autocorrelation, which has impacted the method of data simulation. Table 4.1 shows the first order autocorrelation output for each of the nine countries:

Table 4.1 - First order autocorrelation

Country	Lagrange Multiplier	Prob > LM
Belgium	22.33	<0.0001
Denmark	5.70	0.017
France	4.51	0.034
Germany	2.23	0.135
Netherlands	4.08	0.043
Norway	10.12	0.002
Sweden	6.86	0.009
Switzerland	5.88	0.015
UK	5.16	0.023

The Lagrange Multiplier test for serial correlation shows that the equity return data for all countries, except Germany, exhibit significant serial correlation at a 5 percent level. The test also highlights that serial correlation is strong for Belgium, whereas the rest of the countries exhibit more modest autocorrelation. The existence of autocorrelation in the return series means that special attention must be paid to preserving the time structure in the data when simulating. I will return to this in section 6.2, where the simulations and the following results are presented and discussed. Appendix F shows the ACF output illustrations from SAS.

4.4 Chapter Summary

The data gathering for a multi country comparison study is extensive by nature. The process has been guided by a series of central principles. Firstly, the sample period was chosen to be 1970-2010, based on data availability. Secondly, to enable the best possible comparison base, the sourcing has prioritized credible international sources that provide data for the entire country group.

The MSCI total equity return series is the cornerstone of the data material, as it provides the best available historic data, and is available for all countries. Inflation, consumption, and population data is generally sourced from the IMF through Bloomberg. The risk free return data is the most comprehensive, as quality data does not exist for the period. The risk free return data is therefore constructed from different sources based on a quality ranking, where individual central bank data ranks the highest.

Lastly, the equity data is shown to exhibit first order autocorrelation of varying power. This has implications for the myopic loss aversion analysis, which is discussed in section 6. The next chapters present the results of my analysis.

5 Comparative empirical analysis of equity premium puzzles in selected European countries

This section presents the practical methods and results of the empirical equity premium puzzle analysis. Firstly, the methodology is described. Secondly, the results of the analysis are presented. Thirdly, the results are discussed in relation to the existing empirical findings.

5.1 Methodology of the equity premium puzzle analysis

The analysis of the equity premium puzzle follows the methodology of the original study by Mehra & Prescott (1985), as this provides maximum transparency between the findings. On this basis, the first part of the analysis is the determination of the risk free rate. As described in section 2.1, the risk free rate in the model is calculated from the equation:

$$(\mathbf{2.10})\quad \ln R_f = -\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2$$

Where the exogenous constant of relative risk aversion α is 10 and the subjective impatience factor β is 0.99, in line with the original study. μ_x and σ_x^2 are the mean and variance of consumption growth. Based on the model, the equity return is found from the equation:

$$(\mathbf{2.13})\qquad \ln E(R_e) = \ln(R_f) + \alpha\sigma_x^2$$

Consequently, the explainable equity premium is given by the difference between the model risk-free rate and the model equity return.

5.2 Results of the equity premium puzzle analysis

As outlined in the introduction, the analysis covers nine European countries (Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, Switzerland and the UK) for the period 1970-2010. The real term data inputs used in the model are presented in table 5.1[10]:

[10] The general characteristics of the nominal equity, risk free rate, consumption and inflation data are presented in appendix E

Table 5.1 - Equity premium puzzle model data

Country	Mean real risk-free return (R_f)	Mean real equity return (R_e)	Mean consumption growth (μ_x)	Std. real consumption growth (σ_x)
Belgium	2.84%	5.70%	1.85%	1.56%
Denmark	3.16%	7.14%	0.93%	3.57%
France	2.40%	5.00%	1.77%	1.46%
Germany	2.31%	4.53%	1.79%	3.22%
Netherlands	1.80%	6.52%	1.60%	2.77%
Norway	2.68%	5.78%	2.26%	3.11%
Sweden	2.05%	9.04%	1.76%	3.24%
Switzerland	0.55%	4.77%	1.12%	1.76%
UK	1.57%	4.80%	2.02%	2.55%
Mean	2.2%	5.9%	1.7%	2.6%

Based on these inputs, the observed and explainable equity premia are calculated. Calculations of the observed premia are simply the difference between the mean equity and risk free returns. For example, the observed real equity premium in Belgium is equal to 5.70% minus 2.84%, equating to 2.86%. Continuing the Belgium example, the risk free rate predicted by the model is found by inserting the model data inputs into equation (2.10):

$$(\mathbf{2.10}) \qquad \ln(R_f) = -\ln(\beta) + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2 \Longrightarrow$$

$$\ln(R_f) = -\ln(0.99) + 10 * 0.0185 - \frac{1}{2} * 10^2 * 0.0156^2 = 0.1828 \Longrightarrow$$

$$\boldsymbol{R_f = 20.06}\%$$

Similarly, inserting the data in the model, the equity return equation yields:

$$\ln E(R_e) = 0.1828 + 10 * 0.0156^2 = 0.1853 \Longrightarrow$$

$$\boldsymbol{E(R_e) = 20.36}\%$$

Hence, the explainable equity premium is 20.36% minus 20.06%, equal to 0.29% (allowing for rounding). This is significantly below the observed equity premium of 2.86%, and yields a premium puzzle of 2.86% minus 0.29% equal to 2.57%. The observed and explained equity premia are presented in table 5.2.

Table 5.2 - Equity premium puzzle results

Country	Explained real equity premium	Observed real equity premium	Real equity premium puzzle
Belgium	0.29%	2.86%	**2.57%**
Denmark	1.34%	3.98%	**2.64%**
France	0.26%	2.60%	**2.34%**
Germany	1.20%	2.22%	**1.02%**
Netherlands	0.88%	4.71%	**3.84%**
Norway	1.17%	3.11%	**1.93%**
Sweden	1.20%	6.99%	**5.78%**
Switzerland	0.35%	4.23%	**3.88%**
UK	0.78%	3.23%	**2.44%**
Mean	0.83%	3.77%	**2.94%**

As visible from the table, all the countries in the analysis have higher observed equity premia than the model can explain, meaning that all countries show evidence of an equity premium puzzle over the period 1970-2010. The finding of a premium puzzle is in line with the findings of Mehra & Prescott (1985) in the case of the US. The size of the puzzle however is substantially lower than in the US analysis, as the sample mean of the puzzles is 2.9%, where the reported US puzzle was 4.78%.

The difference between the analysis presented here, and the original US study should not be seen as disqualifying for either of the two, due to the difference in time horizon as well as the difference in regional focus. The results show that the observed premia and the premium puzzles range across the sample countries. In the high end, Sweden has experienced the largest equity premium (approximately 7%), and also the highest puzzle (5.78%). In the opposite end of the scale, Germany has the lowest observed equity premium (only 2.22%), and the smallest puzzle of approximately 1% over the same period. Comparing the explained premium to the original study shows more consistence, as the mean of the explained premia in the analysis is 0.83%, where Mehra & Prescott (1985) found 1.4% in US. This indicates that the differences are driven by the observed premia. Therefore, the observed equity premia are further analyzed, to deepen the analysis and to strengthen the validity and robustness of the findings.

5.3 Validation of the equity premium findings

While no broad research on international empirical equity premium puzzles exist, comprehensive research focusing on observed equity premia across countries can be found in the yearly *Global investment returns* publication by Dimson, Marsh & Staunton (2008; 2011). As the publication, based on their vast multi country DMS database, also presents the development of country equity premia over time, it provides a strong base for comparison for the findings of this paper. Table 5.3 presents the comparable findings over the matching period from 1970 to 2010:

Table 5.3 - Real equity premiums

Country	Observed real equity premium	Dimson, Marsh and Staunton 1970-2010
Belgium	2.86%	2.4%
Denmark	3.98%	3.5%
France	2.60%	4.4%
Germany	2.22%	2.2%
Netherlands	4.71%	4.7%
Norway	3.11%	4.2%
Sweden	6.99%	6.7%
Switzerland	4.23%	4.0%
UK	3.23%	3.9%
Mean	3.8%	4.0%

The table shows that the observed equity premia across the selected European countries, match well with the existing empirical findings for 1970-2010. The comparison shows that Belgium, Denmark, Germany, Netherlands, Sweden, Switzerland, and the UK match well (within 0.5 percent). France and Norway have larger differences of 1.8 and 1.3 percent respectively. Going a step deeper, DMS report that the French premium resorts from a real equity return of 5.7 percent, and a real riskless return of 1,2 percent. In comparison I found that the real equity return was 5 percent, and the real risk-free return was 2.4 percent. The difference is hence driven by differing data for the risk-free rate over the period. As described in section 4.2.3, the data used in this analysis for the risk free rate in France is sourced directly from the central bank from 1993 to 2010, and from the IMF before that, with the two series matching perfectly in the overlapping period. Therefore I feel comfortable with the data used, and the validity of the result.

In the case of Norway, DMS reports that the premium is based on a mean real equity return of 6.9 percent, and a risk free return of 2.6 percent. In comparison, I found that the mean real equity return in the period was 5.8 percent, while the risk free return was 2.7 percent. In this case, the difference is driven by the equity return element. As described in the data section I have chosen to use the MSCI data for all countries to enable the best possible comparison base for the results. As DMS use local Norwegian data, it is possible that the MSCI series for Norway is understating the true equity return. However, with this conditionality the general conclusion is that the empirical findings on observed equity premia match well with the existing research. This validates the broader findings of this paper.

5.4 Chapter summary

The results of the analyses highlight that there is strong evidence of equity premium puzzles across the European country group, as the explainable equity premia are considerably lower than the observed premia for all countries. The average observed equity premium for the sample was 3.77%, while the explainable premium was 0.83%. This finding of an equity premium puzzle is in line with the findings of Mehra & Prescott (1985). The results show that the magnitude of the equity premium puzzle is generally smaller in the European countries than in the original study, with an average puzzle of 2.9 percent vs. the 4.8 percent in the US study. The divergence in magnitude is found to be driven mainly by differences in the observed equity premium component of the model. As the observed equity premia are the results of the development in the local capital markets, there is no intuitive reason that they should align, and hence the divergence should not disqualify either the results of this study nor the original.

To validate the findings, the observed equity premia were compared to the results of the Credit Suisse Global Investment Returns yearly publication authored by Dimson, Marsh & Staunton. The comparison provides strong validation for the results of this analysis as the observed equity premia generally match the Global Investment Return figures well. This also validates the underlying data material, the historical equity and risk-free return series, which in turn provides a strong validity to the remainder of this study, as it is based exactly on this data material.

6 Comparative analysis of myopic loss aversion across selected European countries

This section presents the practical methods and results of the empirical myopic loss aversion analysis in selected European countries between 1970 and 2010. Following the primary results section different sensitivity analyses and further perspectives are presented to strengthen the robustness of conclusions.

6.1 Methodology

The analysis of myopic loss aversion consists of two central elements from the original study by Benartzi & Thaler (1995), the implied evaluation horizon, and the implied equity premiums for varying horizons. The methodologies of these analyses are presented in the following subsections. It is important to note that the method used is slightly different from the original study. The divergence is that the main analysis is based only on the actual observed data over the period. In contrast, the original study employed a bootstrapping simulation method to increase the data material. Simulation based analyses are also performed in this paper, but are only used as a supporting element to the main analysis based on actual data. Further details on this divergence are presented in the last subsection.

6.1.1 Implied evaluation horizon

The implied evaluation horizon is found by calculating the prospective utility of investing in bonds and equities respectively over the period. This calculation is somewhat heavy in computation, and is therefore done through VBA programming (see appendix G for a full transcript of the code). The following presents the mechanics of each step in the calculation.

Firstly, the equity and risk free return series are set up in columns, where each represents the return experienced over a period, from holding a portfolio with either equity or risk free bills. To calculate the prospective utility over varying horizons *H*, the return is compounded over the given horizon. Denoting the monthly returns as r_i, the compounded return x_i over the H month horizon is calculated as expression 6.1:

$$\textbf{(6.1)} \qquad x_i = \prod_{i=1}^{i=H}(1+r_i) - 1$$

The compounded horizon returns are then inserted into the value function, which differs for gains and losses, as the last are felt relatively stronger for a given outcome. Recall from section 3 that the value function is given by:

$$(\mathbf{3.1}) \qquad v(x) = \begin{cases} x^a & if\ x \geq 0 \\ -\lambda(-x)^\beta & if\ x < 0 \end{cases}$$

The constants here follow the methodology of the original study by using the parameters provided from prospect theory, where 2.25 is used for λ describing loss aversion factor, and 0.88 is used for a and β, which describe the curvature of the prospect value function (Tversky & Kahneman, 1992). Using this value function the respective perceived returns $v(x_i)$ are found.

The next step is to sort the returns in ascending order, to find the corresponding decision weights. The returns are therefore given a rank i, starting with 0 for the worst return and $n-1$ for the best return. Based on the rankings, the probabilities (p) of the returns are found from the cumulative distribution. The probability of experiencing an equally good or better return is denoted as p_i, while the probability of experiencing something strictly better is denoted as p_i^*. Given the ranking method then in the positive domain these are defined as:

Equally good or better: $p_i^+ = \frac{(n-i)}{n}$ *Strictly better:* $p_i^{*+} = \frac{(n-i-1)}{n}$

As an example, if one imagines a sample with 10 different returns then the best would be ranked 9 (n-1), the probability of getting something equally good or better would be ((10-9) / 10) = 0.1 and the probability of getting something strictly better would not exist ((10-9-1) / 10) = 0. In the domain for losses the corresponding probabilities are then:

$Equally\ bad\ or\ worse$: $p_i^- = \frac{(i+1)}{n}$ *Strictly worse:* $p_i^{*-} = \frac{i}{n}$

With the individual probabilities, the decision weight associated with the return $v(x_i)$ can be found from the formulas:

$$(\mathbf{3.3}\ \&\ \mathbf{3.4}) \qquad \pi_i^+ = w^+(p_i) - w^+(p_i^*) \text{ and } \pi_i^- = w^-(p_i) - w^-(p_i^*)$$

As described in section 3, w is the capacity of the probability, which for positive and negative returns is given respectively by the expressions:

$$(\mathbf{3.5}\ \&\ \mathbf{3.6}) \qquad w^+(p) = \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{\frac{1}{\gamma}}} \quad and \quad w^-(p) = \frac{p^\delta}{(p^\delta + (1-p)^\delta)^{1/\delta}}$$

Again I follow the methodology of the original study and use the constant parameters provided by Tversky & Kahneman (1992), where γ is 0.61 and δ is 0.69. Inserting the probabilities into weighting function yields the decision weight π_i^+ or π_i^-.

Finally, to obtain the prospective utility, the products of the individual decision weights π_i and returns $v(x_i)$ are summed over all the returns as given in the expression:

$$(\mathbf{3.7}) \qquad V = \sum_{i=-m}^{n} \pi_i v(x_i)$$

Using this method, the prospect utility is calculated for the equity and the risk free portfolio respectively across the varying evaluation horizons. Beginning with *H* =1, meaning the un-compounded monthly returns, the horizon is then increased with one month at a time. The prospect utilities for both assets classes are the plotted against the evaluation horizon, to see where the prospective utility curves intersect. The intersection indicates where myopic and loss adverse investors are indifferent between holding equities and risk free assets – the implied evaluation horizon.

6.1.2 Implied equity premium

The implied equity premium is a essentially a reverse engineering of the prospect utility, which provides the implied equity premia across the different horizons, which can be compared to the empirical results in section 5. The methodology is to add a small constant component to each of the monthly risk free returns, leaving the myopic and loss adverse investor indifferent between holding equities and risk free assets.

Mechanically, the implied premium is found through a few steps. First, the prospective utility of holding only equities and only risk free rate are found for all evaluation horizons. Then, for each specific horizon a small constant factor *z* is added to all months of the risk free return series. Next, the solver function in Excel is used to find the value *z,* which minimizes the difference in prospective utility between the asset classes. The solved value of *z* is then again added to all monthly risk free returns. Lastly, the mean horizon return for equities, and for the risk free assets (plus *z)* are calculated, and the difference between the two means yields the implied equity premium for the given horizon.

The procedure is then repeated for each evaluation horizon. The implied equity premia are then plotted against the evaluation horizons to highlight the relation between the two. This can in turn be compared to the empirical equity premium results from section 5.

6.1.3 Model divergence and data simulation

As mentioned, the original study by Benartzi & Thaler (1995) was based on simulated data, meaning that the authors have drawn random sub samples from the true observed data to extend the amount of data points. There are pros and cons to using simulated data. On the positive side, the extension of the foundational data makes the model less sensitive to single period observations. As an example this paper, focusing exclusively on the period 1970 to 2010, by nature has 492 monthly observations. This means that for longer evaluation horizons there is a limited amount of horizon blocks, which makes the prospective utility sensitive to specific periods. Through simulation, Benartzi & Thaler (1995) drew on an extended series with 100,000 return observations providing a smooth and less sensitive model output. On the negative side, using simulation weakens the empirical strength of the results, as the data analyzed no longer reflects what has actually taken place, but instead reflects the overall data characteristics. There are in my opinion large risks associated with modifying financial data, which is highlighted by the two large equity market bubbles just within the last decade. As I believe the negatives consequences of straying from the historical data outweigh the positive effects of extending the data material through simulation, the main analysis in this paper is based strictly on the true observed data. An additional analysis based on simulation is then performed and presented to support the main results and provide robustness to the conclusions. The simulation is based on random sampling, where different bits of data are drawn from the original series with replacement. Recall from section 4, that the return data was found to have autocorrelation to varying degrees. To preserve this pattern in the data, the simulation is done in blocks matching the different evaluation horizons, so that each horizon return has actually existed in reality. This means that when a random return is selected in the simulation, the following *H* months are drawn with it before a new random return is selected. This is repeated to provide simulated return series with 20,000 observations.

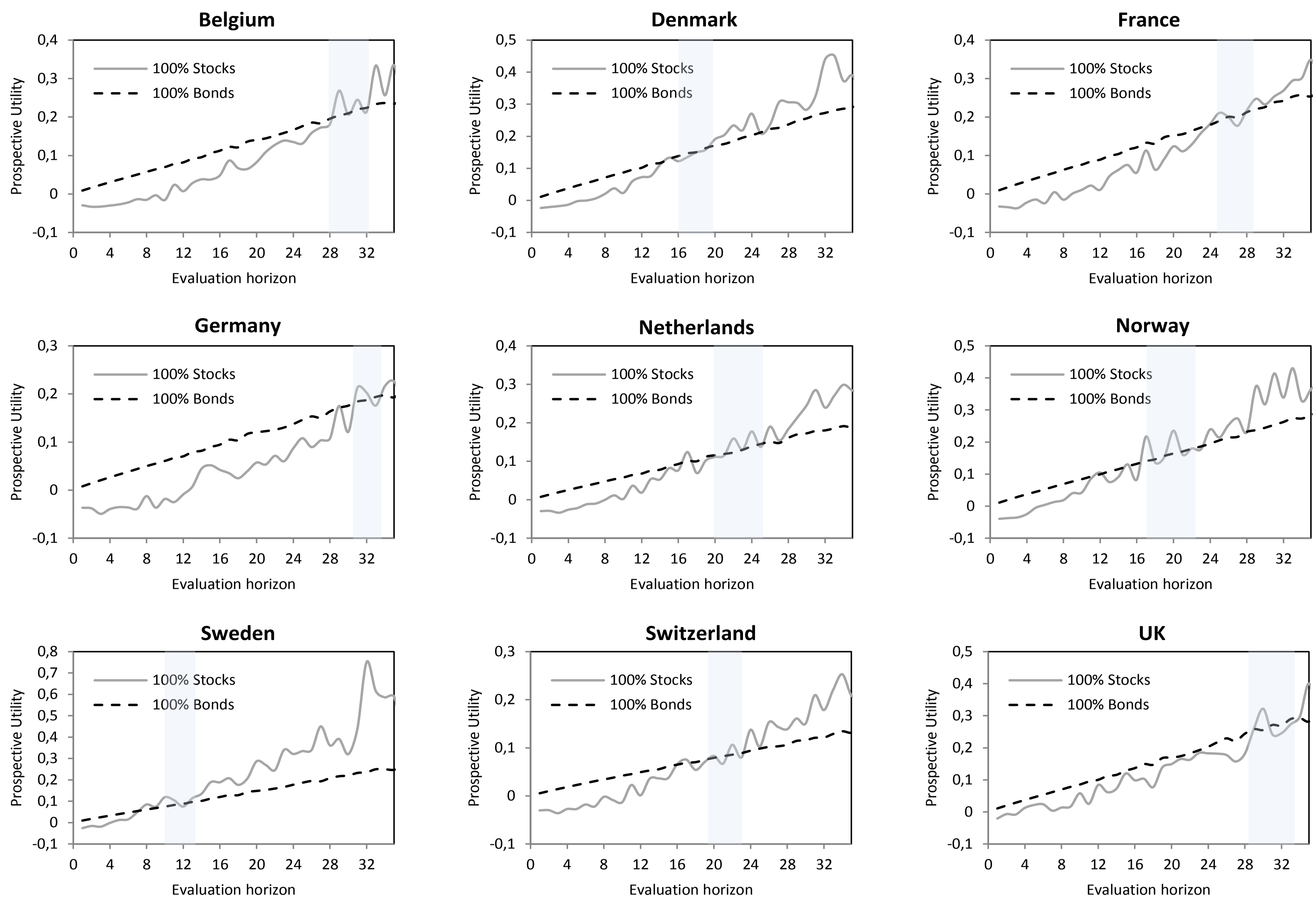
6.2 Myopic loss aversion in Scandinavia and selected European countries

This section presents the results of the empirical analysis of myopic loss aversion for the period 1970-2010 in nine European countries – Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, Switzerland and the UK. Following the primary results, a range of sensitivity analyses and further perspectives are presented, to strengthen the robustness of the conclusions.

6.2.1 Evaluation horizon

The evaluation horizon analyses are based on the monthly nominal return series. The illustrations in figure 6.1 show the prospective utility of investing in equities and Bills across the different evaluation horizons in each of the sample countries. There are a number of interesting implications of the results. First, as expected from theory, all countries show a positive correlation between utility and the evaluation horizon, as highlighted by the upwards trend in the prospective value functions for both Bills and equities. Furthermore, in most cases (all countries except Germany and the UK) the positive correlation is particularly strong for equities, which have significantly higher prospective utility over longer horizons. This is likewise as expected, as the volatile stock returns approach the higher mean return, and the risk of experiencing a loss decreases. The results however also clearly show that the implied evaluation horizons (the intersection), where investors are indifferent between stocks and Bills, are not in line with the 12-month observation from the original study, nor are the horizons aligned across the countries.

Figure 6.1 – Implied evaluation horizons



In contrast, it is visible from the results that the countries differ substantially with regards to implied evaluation horizon. Table 6.1 provides an overview of the implied evaluation horizons across the sample countries:

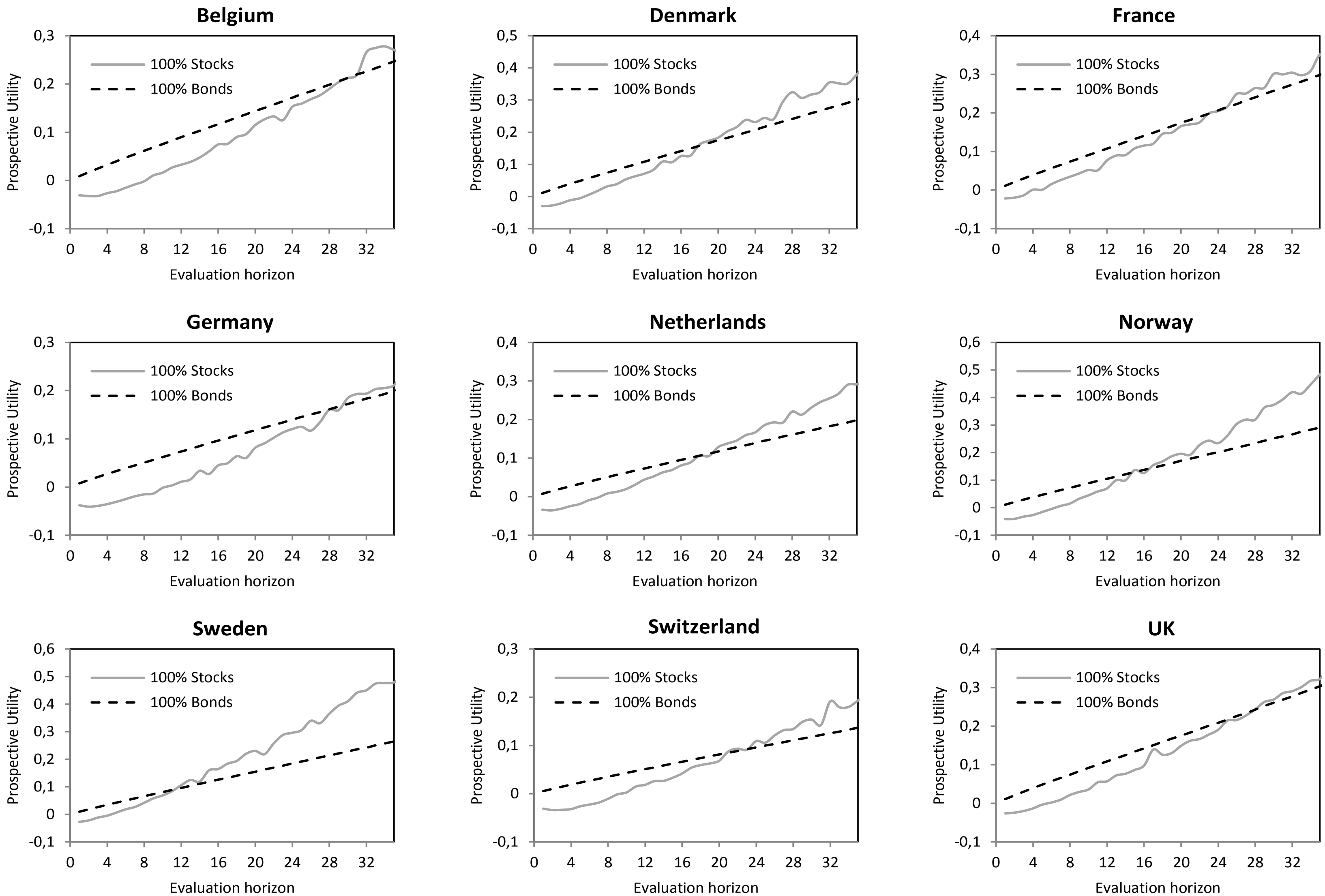
Table 6.1 - Imlied evaluation horizon results

Country	Implied evaluation horizon
Belgium	28-32 months
Denmark	16-19 months
France	24-28 months
Germany	30-33 months
Netherlands	20-24 months
Norway	17-21 months
Sweden	10-13 months
Switzerland	19-23 months
UK	29-33 months
US (Original Benartzi & Thaler study)	12 Months

The results show that the European countries have a longer implied evaluation horizon than the 12 month finding from the US. The European countries can broadly be categorized in three groups. Furthest from the US result are the largest countries – Germany, France and the UK – along with Belgium. This group generally has an implied horizon of more than 25 months, and stretching towards 30 months. The middle group, consisting of the Netherlands, and Switzerland, has an implied horizon of 20-24 months. Lastly, the Scandinavian countries have the lowest implied horizons, and are hence also the closest to the original US result with Sweden matching the finding of the original study.

Due to the limitations in the historical returns data, the prospective utility of holding equities across evaluation horizons in the sample countries exhibit considerable volatility. This makes it difficult to determine exact intersections, making it more sensible to conclude on intersection ranges. A good example is Switzerland where there are several intersections over the horizons ranging from 19-23 months. To support the results found in the primary analyses above, the analyses are also performed on the basis of simulated data. The results are presented in figure 6.2:

Figure 6.2 – Simulated implied evaluation horizons



The simulation follows the methodology from the original study by Benartzi & Thaler (1995), where random data points are drawn with replacement from the historical data series. Based on the existence of first order autocorrelation (see section 4.3), the simulated data is drawn in blocks that match the horizon analyzed. This ensures that the time structure of the data is sustained in the simulation, and that all data points are in fact returns that have occurred historically. The simulation results broadly support the primary analyses, and provide more clear-cut estimations of the implied evaluation (Table 6.2).

Table 6.2 - Implied evaluation horizon results - Simulation

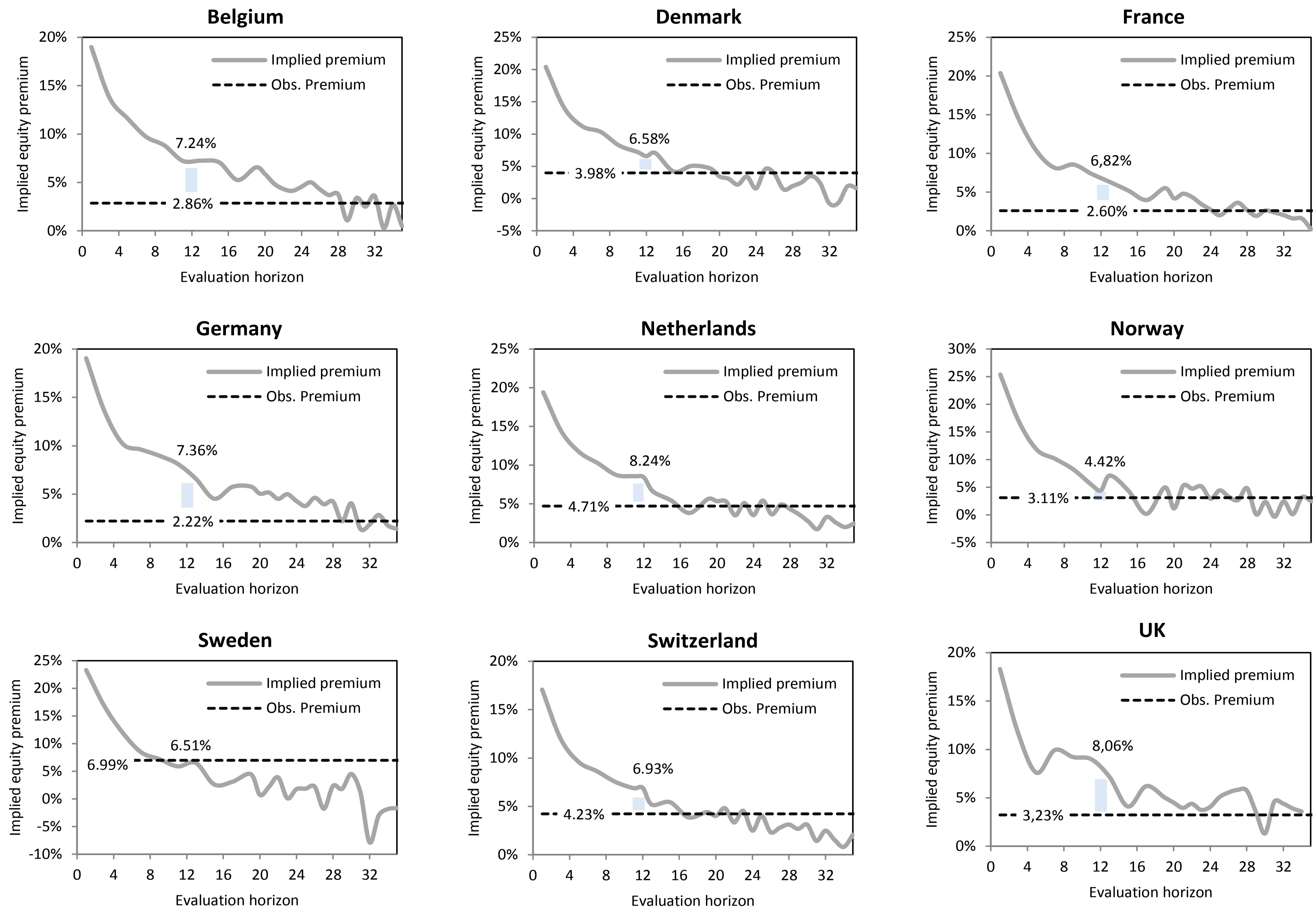
Country	Implied evaluation horizon
Belgium	30 months
Denmark	17 months
France	24 months
Germany	29 months
Netherlands	20 months
Norway	16 months
Sweden	12 months
Switzerland	21 months
UK	28 months
US (Original Benartzi & Thaler study)	12 Months

Based on the primary analysis, and further supported by the simulation tests, it is clear that the implied evaluation horizons across the sample countries are not in line with the original study. Sweden is the only country that fits the model prediction of a 12-month evaluation horizon. The remaining sample countries all have longer implied horizons, with Scandinavian countries as the closest to the prediction, while the larger European countries along with Belgium are the furthest away from the findings in the US.

6.2.2 Implied equity premium

The analyses of the implied equity premia provide results that can be compared not only to the original study, but also to the results of the equity premium puzzle analysis presented in section 5. Figure 6.3 presents an illustration of the implied equity premium across the evaluation horizons for each country. As expected, the implied premium falls as the evaluation horizon increases – seen by the downwards sloping trend. In line with the initial results, the 1 year horizon implied equity premium does not match the observed equity premium, as was the case in the study of Benartzi & Thaler (1995).

Figure 6.3 – Implied equity premia



The analyses instead show that the implied equity premiums are substantially higher at the 1 year horizon across the European country group. The results of the implied equity premium analyses and the observed premiums are summarized in Table 6.3:

Table 6.3 - Observed equity premium vs. implied premium

Country	Observed equity premium	Implied 6M horizon	Implied 12M horizon	Implied 18M horizon	Implied 24M horizon	Implied 30M horizon	Implied 36M horizon
Belgium	2.86%	10.6%	**7.2%**	5.9%	4.6%	3.4%	0.5%
Denmark	3.98%	10.8%	**6.6%**	4.9%	1.6%	3.5%	1.6%
France	2.60%	9.2%	**6.8%**	4.7%	2.7%	2.6%	0.2%
Germany	2.22%	9.9%	**7.4%**	5.8%	4.3%	4.1%	1.4%
Netherlands	4.71%	10.9%	**8.2%**	4.7%	3.5%	2.7%	2.5%
Norway	3.11%	11.0%	**4.4%**	2.6%	2.9%	2.4%	2.5%
Sweden	6.99%	10.2%	**6.5%**	3.8%	1.8%	4.5%	-1.7%
Switzerland	4.23%	9.1%	**6.9%**	4.1%	2.5%	3.1%	2.1%
UK	3.23%	8.8%	**8.1%**	5.6%	4.1%	1.3%	0.2%
US (Original study)	6.2%	-	5.9%	-	2.4%	-	-

Again, Sweden stands out as the one country in which the results fit with the conclusions from the original US study. Also, as in the evaluation horizon part of the analysis, the countries differ in groups, with the Scandinavian results differing the least from those of Benartzi & Thaler (1995), the results from the Netherlands and Switzerland further away, and with Germany, France, the UK and Belgium the furthest from the 1 year horizon match.

6.2.3 Initial conclusion

The results are in line with the theoretical prediction, in that all countries exhibit falling implied premium for longer horizons. The results highlight how changes in the horizon influence the outcome for myopic investors. If a myopic loss adverse Dutch investor for example shifted his portfolio evaluation frequency from once every 18th month to every third year, the required premium for holding equities would be in the area of 2-3 percent, rather than the 4-5 percent premium implied for the shorter horizon. Therefore, a Dutch investor with a 3 year investment horizon who evaluates his portfolio every 18th month, given that the overall market behavior remains unchanged, is “paying” around 2-3 percent yearly as a “cost of myopia”.

Based on the results from the implied evaluation horizon and the implied equity premium analyses, it is clear that myopic loss aversion as presented by Benartzi & Thaler in their US study is a convincing explanation of the equity premium puzzle in Sweden in the period from 1970 to 2010. However, this is not the case when looking at the general European country group. The approach provides some intuitive explanation for the Scandinavian countries, but especially the results from larger countries are diverging largely from the conclusions of the original study. It is interesting to note that the Swedish finding, where myopic loss aversion appears to provide a solution to the equity premium puzzle, matches the conclusion of the study by Læssøe & Diernisse, who found support for the approach focusing solely on the case of Sweden for the period 1925-2010 (Læssøe & Diernisse, 2011).

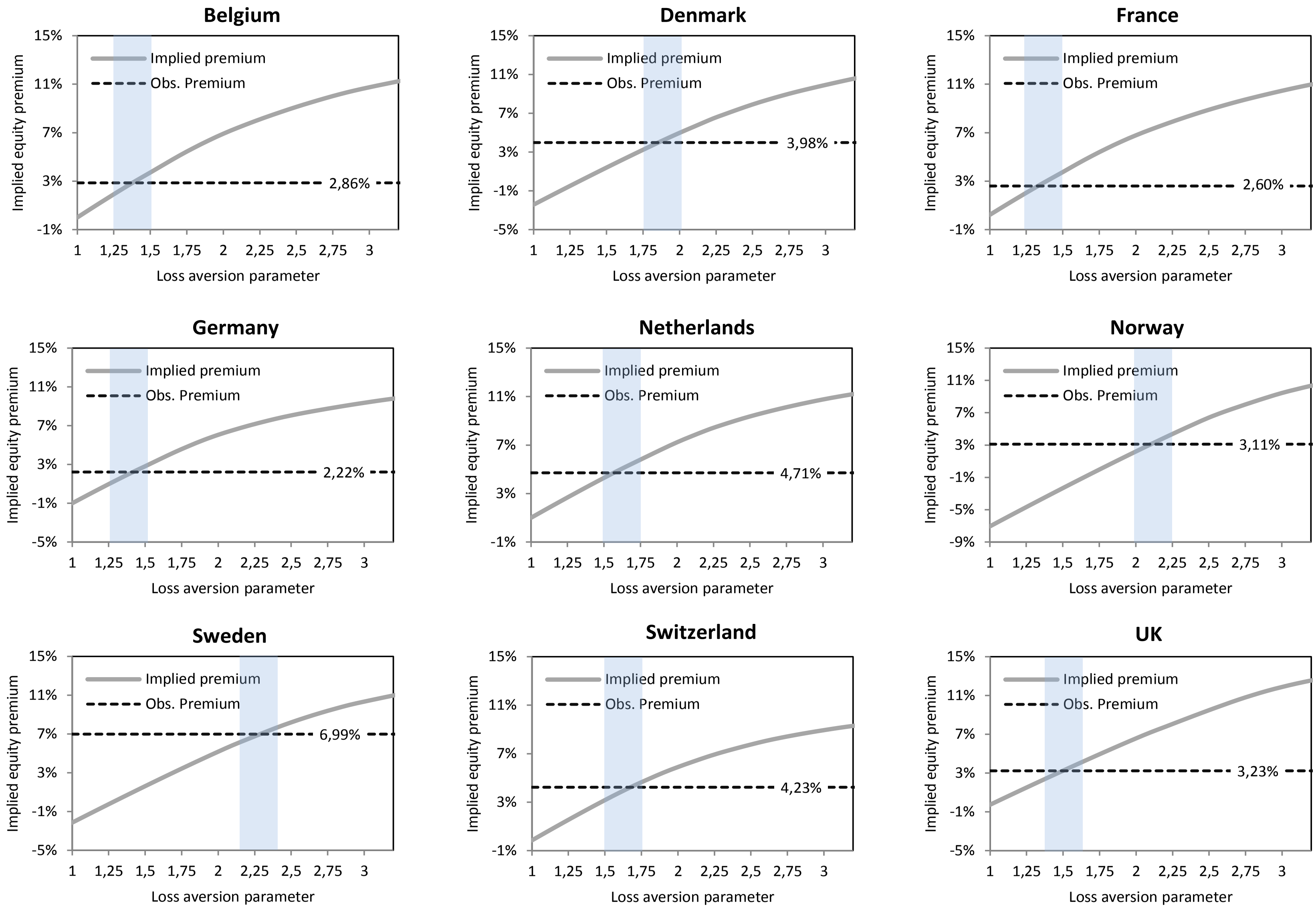
The initial conclusion is that if myopic loss aversion is the solution to the equity premium puzzle, then the evaluation period for investors is 1) longer than that of US investors except for in Sweden and, 2) widely varying across the comparison group in Europe. Based on this myopic loss aversions conclusively fails to solve the equity premium puzzle in this comparative analysis. The question is then why myopic loss aversion does not provide a convincing explanation. The next sections provide sensitivity analyses, which search to answer this question.

6.3 Allowing for changes in loss aversion

A central part of the myopic loss aversion model is naturally the loss aversion input – or the aggravation parameter. Recall from methodology section, that the main analyses used the fixed parameter input λ = 2.25 from prospect theory, in line with the study of Benartzi & Thaler (1995). However, as the descriptive loss aggravation factor was based on experimental evidence published in 1992 by Tversky & Kahneman, it is not set in stone that the parameter value of 2.25 should be strictly constant over time and space. The question is whether changes in the loss aversion parameter could explain the results from the primary analysis - or put differently, how sensitive are the results to changes in loss aversion.

To test the sensitivity of the aggravation parameter, the implied equity premia are recalculated for different loss aversion coefficients, while assuming that the evaluation horizon is fixed to 12 months, in line with original findings. Figure 6.4 shows the results of the sensitivity analyses. The explainable equity premium is found to be sensitive to the changes in loss aversion, which is visible from the positive slopes of the country charts, indicating that even smaller changes to the loss aversion parameter have substantial effects on the implied equity premium.

Figure 6.4 – Implied equity premiums vs. loss aversion



The light blue columns in the charts highlight the intersection between the implied equity premium and the observed equity premium. These provide estimates of the implied loss aversion parameters that would "solve" the equity premium puzzle. If changes in loss aversion are the reason for the divergence between the observed and implied equity premium, then the investors in Belgium are for instance hurt between 1.25 and 1.5 times more by a loss than they are pleased by a gain of the same size.

The implied loss aversion parameters for all sample countries are summarized in table 6.4:

Table 6.4 - Implied risk aversion

Country	Implied risk aversion (λ)
Belgium	1.25 - 1.5
Denmark	1.75 - 2
France	1.25 - 1.5
Germany	1.25 - 1.5
Netherlands	1.5 - 1.75
Norway	2 - 2.25
Sweden	2.15 - 2.4
Switzerland	1.5 - 1.75
UK	1.35 - 1.6
US (Original Benartzi & Thaler study)	2.25

While it is clear that changes in loss aversion would impact the results of the analyses, the results of this sensitivity test show that the changes would have to be of a considerable magnitude (as low as half of what was found empirically) to explain the observed returns.

It is difficult to say conclusively whether this is a plausible explanation to the varying results from the analysis of myopic loss aversion in the European comparable study, as there is no empirical country research on the behavioral culture. Two arguments however go against this as the decisive driver. Firstly, the magnitude of change in behavior needed to explain the results is significant, and as large as a 50 percent decrease. Secondly, changes in loss aversion do not provide intuitive insight into the divergence within the European country group. That the loss aversion in Belgium should be half of that in Sweden is difficult imagine. Based on this it can be concluded that potential changes in loss aversion from the original parameter value do not in itself provide a convincing explanation to the primary analysis results. It is however clear that further research on loss aversion behavior across cultures would be highly valuable, as even smaller changes would alter the myopic loss aversion conclusions considerably.

Consequently, the following section will revisit the historical data, in search for any insight that may explain the primary results.

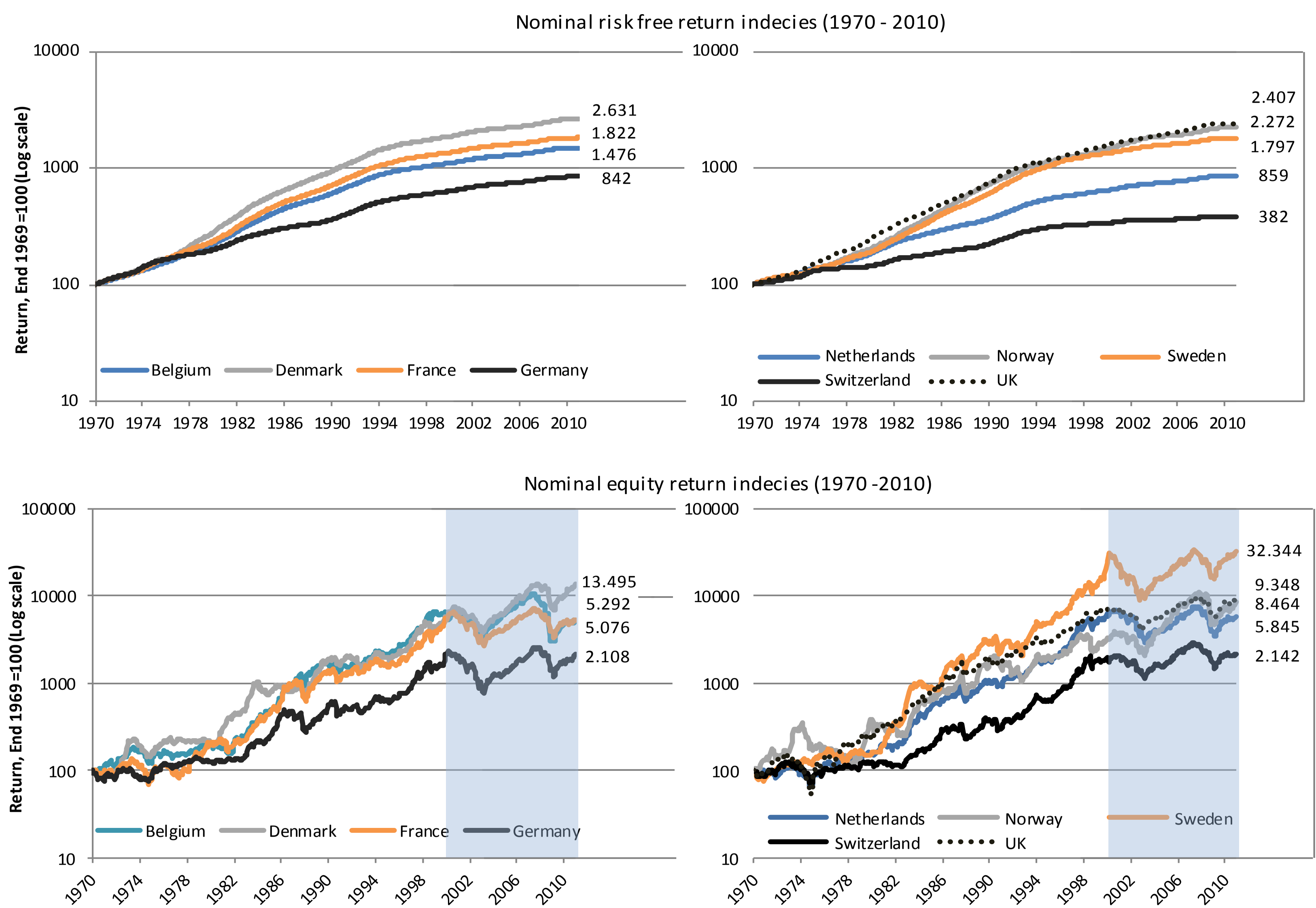
6.4 Revisiting the data – the lost decade of equities

Having tested the key outside input in the model, the focus is instead turned to the internal input – the data. This section revisits the historical return data to see if the results could be explained from in patterns in the data. Figure 6.5 presents the historical return indices in nominal terms, as used in the primary analysis. The return series are illustrated on logarithmic scales to highlight the pattern over the entire period. Looking first at the risk free returns indices, it is clear that while the absolute return differs from Switzerland in the low end to Denmark in the high end, the indices are homogenous in pattern. All indices have positive slopes over the period, which flatten out somewhat over the last 10 years where yields have been low, but all indices remain upwards sloping. This is as expected as nominal yields have naturally been positive to provide an inventive for investors to loan money to the sovereigns[11]. Turning the focus to the equity return indices, the picture is different and highly interesting.

As with the risk free investments the absolute return on equities have differed substantially over the period. Swedish equities have performed the best, significantly superseding the followers Denmark and UK. German and Swiss stocks have delivered the lowest returns to investors. All indices (except for Switzerland in the 1970's) share a strong positive pattern over time, until the turn of the century. Over the last 10 years of the period, the pattern in most countries changed significantly. The period in focus has been highlighted in the illustrations, which shows a surprising development.

[11] It is worth noting that this "natural rule" of positive nominal yields on risk free investments was recently broken. In 2011, for the first time in financial market history, short Swiss yields became negative. This happened on the back of "flight-to-quality" sentiment among investors worried about the ongoing sovereign debt crisis, who were willing to pay money to be protected by the strong Swiss economic safety.

Figure 6.5 – Historical return indices



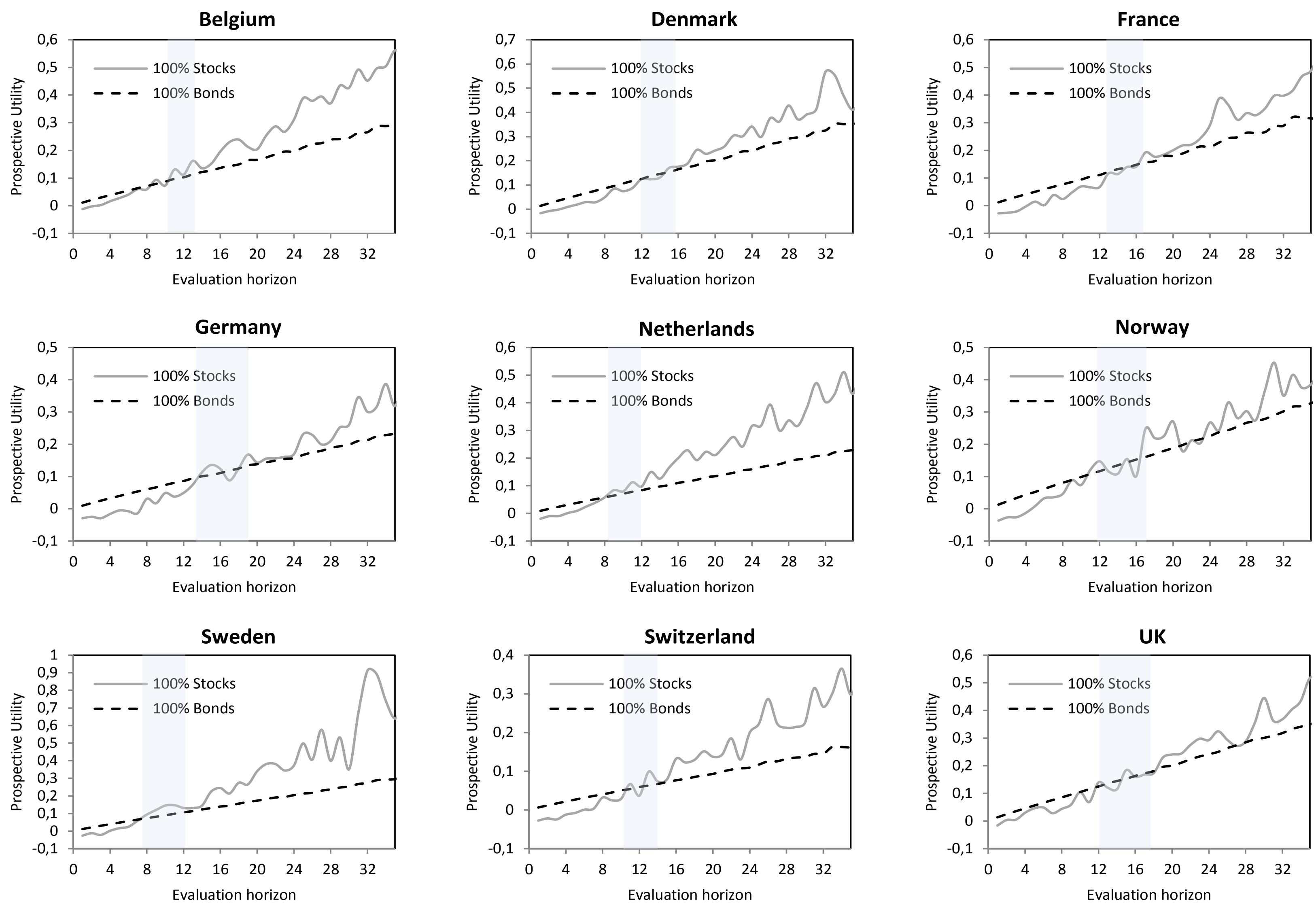
Between 2000 and 2010 it appears that investors in a number of countries have not gained any return on the equity investment. Meanwhile, investors have experienced considerable volatility, highlighted by the large swings in the return series over the period, which include both the dot.com bubble downturn in the early part of the decade, and the recent financial crisis towards the end. Table 6.5 presents the mean return and standard deviation on equities across the sample group broken down into decades.

Table 6.5 - Equity risk and return over time

Country	1970's		1980's		1990's		2000 - 2010	
	Return	Stdev.	Return	Stdev.	Return	Stdev.	Return	Stdev.
Belgium	7.0%	12.8%	21.5%	18.6%	13.5%	18.2%	-2.4%	20.0%
Denmark	7.6%	14.3%	21.5%	18.6%	11.6%	18.2%	7.6%	20.0%
France	6.5%	21.1%	19.8%	22.1%	13.9%	19.1%	-0.6%	19.0%
Germany	2.2%	14.9%	14.9%	19.9%	13.5%	20.2%	-0.1%	23.4%
Netherlands	4.3%	16.3%	19.5%	19.1%	17.7%	16.0%	-0.7%	21.1%
Norway	13.2%	26.4%	15.0%	28.1%	6.8%	23.8%	8.5%	25.0%
Sweden	4.3%	16.5%	30.0%	22.3%	20.5%	24.6%	2.7%	25.3%
Switzerland	2.0%	17.3%	11.2%	16.5%	16.4%	18.1%	0.9%	15.3%
UK	8.7%	26.8%	20.8%	19.7%	13.3%	14.2%	2.3%	15.4%
Total country group	6.2%	18.5%	19.4%	20.7%	14.2%	18.9%	2.0%	20.8%
Scandinavia	8.3%	19.1%	22.2%	23.0%	13.0%	22.2%	6.3%	23.4%
Other countries	5.1%	18.2%	18.0%	19.5%	14.7%	17.2%	-0.1%	19.6%

The break down reveals a highly interesting picture. The statistics elaborate on the shifting characteristic of equity return in the last decade, visible from the illustrations in the figure 6.5. The mean return of the overall group falls to only 2 percent in annual return over the last 10 years. Even more interesting is the individual country differences. Isolating the Scandinavian subgroup, for which the myopic loss aversion results provided the strongest explanatory power of the equity premium, shows that the development diverges further. Over the last 10 years, the average return on Scandinavian equities was 6.3 percent, while the comparable return for the remaining countries was -0.1 percent. Over the same period the corresponding volatility was closer, with a standard deviation of 23.4 percent annually for Scandinavian equities vs. 19.6 percent in the other group. This means that investors in the countries outside Scandinavia were not receiving any return, while still experiencing the highest volatility across the period. To isolate the effect of this radically different last decade, a new myopic loss aversion analysis is done for the first 30 years alone.

Figure 6.6– Evaluation period analysis (1970-2010)



When using only the data for the first 30 years of the period, the results are much more supportive of the myopic loss aversion approach to explaining the equity premium. Table 6.6 summarizes the new implied evaluation horizons.

Table 6.6 - Implied evaluation horizon results - 1970-2000

Country	Implied evaluation horizon
Belgium	10-13 months
Denmark	12-15 months
France	13-17 months
Germany	14-18 months
Netherlands	9-12 months
Norway	12-17 months
Sweden	8-12 months
Switzerland	11-14 months
UK	12-17 months
US (Original Benartzi & Thaler study)	12 Months

Belgium, Denmark, Netherlands, Norway, Sweden, Switzerland and UK now have implied evaluation horizon ranges similar to the 12-month finding of Benartzi & Thaler (1995). Germany and France have ranges that are longer than 12 months, but still not far away. Myopic loss aversion provides a convincing explanation for the equity premium puzzle across the European country group in the period 1970-2000. However, as a 10 year period cannot plausibly be categorized as an outlier, this insight does not rectify the original failure of the model. Instead it provides a strong explanation to why myopic loss aversion fails – namely the unique development for European equities. The intuitional merit is strong, as the approach is essentially based on a premium driven by volatility, which causes investors to experience losses felt relatively harder than gains. Naturally, during a period like the last 10 years, where high volatility is not accompanied by returns, the investor will have large disutility from equities – so much even that the relationship, which seem to fit with theory in the first 30 years of the period, is distorted on an aggregate level. As Scandinavian equities have not to the same extent experienced such a volatile return-less period, the myopic loss aversion approach can better explain the equity premium in these countries. In conclusion, while it is outside the scope of this paper to deliberate on what has caused it, the unique equity market development since the turn of the century provides a strong and convincing insight to understanding the results of this paper. However, it is important to note that this explanation represents only one possible answer, and that other factors could be affecting the overall picture.

6.5 Chapter summary

The analysis shows that in contrast to the original study by Benartzi & Thaler (1995), myopic loss aversion cannot convincingly explain the equity premium puzzle for the European country group for the period 1970-2010. The method has some explanatory merit for the Scandinavian countries, where especially the results for Sweden support the theory, but the results for the larger countries are highly diverging from the observed premia. This leads to an initial conclusion that myopic loss aversion fails to solve the puzzle.

A sensitivity test shows that changes in loss aversion behavior can impact the results significantly. However, as an explanation and remedy to the initial results, this theory falls short on two main accounts. Firstly, the magnitude of change in loss aversion needed to explain the results seems too extensive to be plausible. Also, it cannot provide any insight into the large inter-country differences.

An extensive analysis of the historical market developments, highlights a significant shift in the pattern of equity returns occurring over the last decade, where a large share of the countries, specifically non-Scandinavian countries, have seen either negative or flat mean nominal equity returns, in combination with high volatility. To isolate the effect of this development, the sample group is analyzed again without this last period. The results of this analysis show a much stronger support for myopic loss aversion as explanation for the equity premium puzzle across the sample countries. In turn, it can be concluded that the specific development in some European equity markets present a convincing explanation to the initial results, as it explains why the myopic loss aversion approach fails at the aggregate level, and also why it works substantially better for the Scandinavian countries. It is unclear to which extent the effect of this last decade would fade from extending the data beyond the beginning of the period in 1970. However, as a 10 year period cannot plausible be described as an outlier event, the overall conclusion from the comparative empirical study remains that myopic loss aversion in the original format cannot, in contrast to the US conclusion, solve the equity premium puzzle in Europe over the last 40 years.

7 Conclusion

The aim of this study was explore the existence of an equity premium puzzle in a comparative European context, and to test whether myopic loss aversion could provide a solution to such a puzzle.

The analysis of the equity premium puzzle showed that there was in fact evidence of substantial puzzles in all the countries investigated. The equity premium puzzles in Europe were found to be differing among the sample countries, and on a generally all the puzzles appeared considerably smaller in magnitude, compared to the original study by Mehra & Prescott (1985).

Further investigation highlighted that the divergence from the original study, was driven primarily by differences in the observed capital market developments. As the key driver, these where tested against highly regarded existing research on the observed equity premium for the same sample period, and the initial results were found to be strongly validated. In conclusion, the analysis provides strong empirical support for the equity premium puzzle argument, as well as a validation of the magnitude of the overall European puzzle, as well as the individual country puzzles over the last 40 years.

Having confirmed the existence of equity premium puzzles across the European country group, the study proceeded to test the ability of myopic loss aversion to explain these findings. Using the same validated historical data, the analysis showed that - except for in the case of Sweden - myopic loss aversion could not convincingly explain the equity premium puzzle. Particularly, the results from the large European countries (Germany, France, and UK) and Belgium showed that myopic loss aversion, in the format presented by Benartzi & Thaler (1995), did not provide a valid solution to the puzzles. The results highlighted the value of testing economic models in a comparative format, as an investigation solely focused on Sweden for example would have concluded the opposite – namely that myopic loss aversion successfully solves the puzzle.

To understand the results, a sensitivity test of the key model assumption, namely the loss aversion parameter, was performed. The test showed that while the results are sensitive to changes in loss aversion, the magnitude of change required for myopic loss aversion to explain the observed equity premium seems implausible, as investors in the large European countries would have to have been only half as loss averse as previously assumed. Also, even if a change in loss aversion is the reason for the divergence from the original US study, such changes cannot explain the large intra-sample differences. In particular, Scandinavian investors would have to have significantly different preference structures compared their European peers. It was therefore concluded that potential changes in loss aversion behavior cannot fully explain, or rectify, the failure of myopic loss aversion as a solution to the puzzle.

Lastly, the historical data was examined in search of patterns in the capital market development that could explain the results. This highlighted a highly interesting change in the equity returns over the last decade. Over the last 10 years, equities have on average yielded slightly negative annual return for investors outside Scandinavia. Meanwhile, with two equity market crashes in the period, the volatility has not fallen along with the return, but rather stayed historically high. Such an environment naturally impacts the myopic loss aversion model considerably, as the high volatility without return compensation leads myopic investor to experience a higher frequency of losses, to which they are adverse. To isolate the effect of this 'lost decade of equities', a new analysis was made focusing on the first 30 years of the period. This analysis showed a contrastingly large ability of myopic loss aversion to explain the observed premia across all countries in the sample. However, as a 10 year period cannot be described as an outlier event, the final conclusion is that the specific development on European equity markets can explain why the myopic loss aversion approach fails, but not rectify the failure.

One broader perspective can be drawn from this paper, namely that further research on behavioral patterns across countries, cultures, and time, would be highly valuable, not only to myopic loss aversion, but to behavioral finance in general. While the descriptive behavioral insights have considerable intuitive merits, the area could gain large validity and transparency from more indebt evidence of behavioral similarities and divergences across countries, ages, genders etc.

In addition to the academic contribution of the analysis, a number of more practical perspectives can also be drawn from this paper. Firstly, the results highlight how one should be extremely careful and skeptic, with regards to relying on models for predictions on capital markets. The 'fat tail' nature of markets is shaped by statistically improbably events that are highly challenging to models, as in the case of this study. This perspective is highly relevant in a time where the sovereign debt problems, particularly severe in Southern Europe, are threatening to throw the global economy into a renewed recession. While a third recession within such a in short period is very statistically improbable, this is not the determining factor for the actions of Greek and European politicians who will decide on the outcome.

Secondly, while myopic loss aversion cannot explain the observed equity premia, the theory and results of this paper provide a strong and consistent message across all tests performed. Investing with a short horizon has historically been very costly. This implies that initiatives, which could help long-term investors extend their evaluation horizon, could be valuable. Banks could for instance publish investment performance reports to clients less frequently, or offer to handle the investment reporting to taxing authorities, thereby not requiring individual investor to go through the formal process each year. Also, this insight is interesting in regard to professional investment departments, where the typical reporting system of daily or hourly profit & loss reports are perhaps not exactly helping the efforts towards unbiased decision making process.

Finally, while this study has focused on myopic loss aversion as the potential solution to the equity premium puzzle, it is important to highlight, as was visible from the literature review, that this is only one of multiple approaches. As some of these approaches have been argued (at least partly) to provide viable solutions to the equity premium puzzle in the US, similar comparative studies could give insight to their broader merit and further strengthen the general understanding of investor preferences, along with their implications for risk and return in international capital markets.

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Appendices

Appendix A – Risk aversion and the utility function

The Arrow-Pratt coefficient of relative risk aversion (CRRA) is defined as R(c)

$$(\mathbf{A.1}) \qquad R(c) = \frac{-c_t U''(c_t)}{U'(c_t)}$$

Mehra & Prescott assume investor preferences follow the isoelastic utility function stated in equation (2.2)

$$(\mathbf{2.2}) \qquad \boldsymbol{U(c,\alpha)} = \frac{\boldsymbol{c^{1-\alpha} - 1}}{\boldsymbol{1-\alpha}}, \qquad \mathbf{0} < \alpha < \infty$$

Its first and second derivatives are

$$(\mathbf{A.3}) \qquad U'(c_t) = (1-\alpha)c^{-\alpha}\frac{1}{1-\alpha} = c_t^{-\alpha}$$

$$(\mathbf{A.4}) \qquad U''(c_t) = -\alpha c_t^{-\alpha-1}$$

It can then be shown that the coefficient of relative risk aversion is a constant, as

$$(\mathbf{A.5}) \qquad R(c) = \frac{-c_t(-\alpha c_t^{-\alpha-1})}{c_t^{-\alpha}} = \frac{\alpha c_t c_t^{-\alpha-1}}{c_t^{-\alpha}} = \frac{\alpha c_t^{-\alpha}}{c_t^{-\alpha}} = \alpha$$

The elasticity of intertemporal substitution (EIS) is defined as

$$(\mathbf{A.6}) \qquad EIS = \frac{U'(c_t)}{-c_t U''(c_t)} \quad or \quad \frac{1}{\alpha}$$

i.e. the reciprocal of the CRRA.

Appendix B – Expected return on equity investments

The basic pricing relationship is stated in equation (2.4)

$$(\mathbf{2.4}) \qquad \boldsymbol{p_t U'(c_t) = \beta E[(p_{t+1} + y_{t+1}) U'(c_{t+1})]}$$

$$(\mathbf{B.2}) \qquad 1 = \beta E_t \left[\frac{(p_{t+1} + y_{t+1}) U'(c_{t+1})}{p_t U'(c_t)} \right]$$

$$(\mathbf{B.3}) \qquad 1 = \beta E_t \left[\frac{p_{t+1} + y_{t+1}}{p_t} \frac{U'(c_{t+1})}{U'(c_t)} \right]$$

As stated in equation 2.5 the return on equity is defined as:

$$(\mathbf{2.5}) \qquad R_{e,t+1} = \frac{p_{t+1} y_{t+1}}{p_t}$$

Based on this definition equation B.3 can be formulated as:

$$(\mathbf{B.4}) \qquad 1 = \beta E_t \left[R_{e,t+t} \frac{U'(c_{t+1})}{U'(c_t)} \right]$$

As the future return from holding the risk free asset is known, the equivalent relationship for the risk-free asset is:

$$(\mathbf{B.5}) \qquad 1 = \beta E_t \left[\frac{U'(c_{t+1})}{U'(c_t)} \right] R_{f,t+t}$$

Inserting the individual expectations for each of the parts in equation (B.4) leads to:

$$(\mathbf{B.6}) \qquad 1 = \beta \left[E_t \left(\frac{U'(c_{t+1})}{U'(c_t)} \right) E_t(R_{e,t+1}) + Cov \left(\frac{U'_{t+1}}{U'_t}, R_{e,t+1} \right) \right]$$

$$(\mathbf{B.7}) \qquad 1 = \beta E_t \left(\frac{U'(c_{t+1})}{U'(c_t)} \right) E_t(R_{e,t+1}) + \beta Cov \left(\frac{U'_{t+1}}{U'_t}, R_{e,t+1} \right)$$

Rearranging the relationship for the risk-free asset in equation (B.5)

$$(\mathbf{B.8}) \qquad 1 = \beta E_t \left(\frac{U'(c_{t+1})}{U'(c_t)} \right) R_{f,t+t} \quad \Leftrightarrow \quad \frac{1}{R_{f,t+t}} = \beta E_t \left(\frac{U'(c_{t+1})}{U'(c_t)} \right)$$

Inserting this in equation (B.7) yields:

$$(\mathbf{B.9}) \qquad 1 = \frac{1}{R_{f,t+t}} E_t(R_{e,t+1}) + \beta Cov \left(\frac{U'_{t+1}}{U'_t}, R_{e,t+1} \right)$$

Multiplying the risk-free return on both sides yields:

$$(\mathbf{B.10}) \qquad R_{f,t+t} = E_t(R_{e,t+1}) + R_{f,t+t}\, \beta Cov \left(\frac{U'_{t+1}}{U'_t}, R_{e,t+1} \right)$$

Further rearranging equation (B.5) gives

$$(\mathbf{B.11}) \qquad 1 = \beta E_t\left(\frac{U'(c_{t+1})}{U'(c_t)}\right) R_{f,t+t} \;\; \Leftrightarrow \;\; R_{f,t+t} = \frac{1}{\beta E_t\left(\frac{U'(c_{t+1})}{U'(c_t)}\right)} \quad \Leftrightarrow$$

$$R_{f,t+t} = \frac{1}{\beta} E_t\left(\frac{U'(c_t)}{U'(c_{t+1})}\right)$$

Inserting this is equation (B.10)

$$(\mathbf{B.12}) \qquad R_{f,t+t} = E_t\left(R_{e,t+1}\right) + \frac{1}{\beta} E_t\left(\frac{U'(c_t)}{U'(c_{t+1})}\right) \beta Cov\left(\frac{U'(c_{t+1})}{U'(c_t)}, R_{e,t+1}\right)$$

Where the β components cancel out yielding:

$$(\mathbf{B.13}) \qquad R_{f,t+t} = E_t\left(R_{e,t+1}\right) + E_t\left(\frac{U'(c_t)}{U'(c_{t+1})}\right) Cov\left(\frac{U'(c_{t+1})}{U'(c_t)}, R_{e,t+1}\right)$$

Given that marginal utility, $U'(c_t)$ is known at time t this means:

$$(\mathbf{B.14}) \qquad R_{f,t+t} = E_t\left(R_{e,t+1}\right) + \frac{U'(c_t)}{E[U'(c_{t+1})]} Cov\left(\frac{U'(c_{t+1})}{U'(c_t)}, R_{e,t+1}\right)$$

Asserting that $\mathrm{Cov(aY, bX) = abCov(Y, X)}$ this re-writes to:

$$(\mathbf{B.15}) \qquad R_{f,t+t} = E_t\left(R_{e,t+1}\right) + \frac{U'(c_t)}{E[U'(c_{t+1})]} \frac{1}{U'(c_t)} Cov\left(U'(c_{t+1}), R_{e,t+1}\right)$$

$$(\mathbf{B.16}) \qquad R_{f,t+t} = E_t\left(R_{e,t+1}\right) + \frac{1}{E[U'(c_{t+1})]} U'(c_t) \frac{1}{U'(c_t)} Cov\left(U'(c_{t+1}), R_{e,t+1}\right)$$

$$(\mathbf{B.17}) \qquad R_{f,t+t} = E_t\left(R_{e,t+1}\right) + Cov\left(\frac{1}{E[U'(c_{t+1})]} U'(c_{t+1}), \frac{1}{E[U'(c_{t+1})]} R_{e,t+1}\right)$$

$$(\mathbf{B.18}) \qquad R_{f,t+t} = E_t\left(R_{e,t+1}\right) + Cov\left(\frac{U'(c_{t+1}), R_{e,t+1}}{E[U'(c_{t+1})]}\right)$$

$$(\mathbf{B.19}) \qquad E_t\left(R_{e,t+1}\right) = R_{f,t+t} - Cov\left(\frac{U'(c_{t+1}), R_{e,t+1}}{E[U'(c_{t+1})]}\right)$$

Which yields **equation (2.6):**

$$(\mathbf{2.6}) \qquad \boldsymbol{E_t\left(R_{e,t+1}\right) = R_{f,t+t} + Cov\left(\frac{-U'(c_{t+1}), R_{e,t+1}}{E[U'(c_{t+1})]}\right)}$$

This yields a more intuitive relation where the expected return on a risky asset is equal to the risk-free return plus a risk premium component given by the covariance between risky asset and consumption.

Appendix C – Introducing growth in the asset pricing equation

The basic pricing relationship is stated in equation (2.3):

$$(\mathbf{2.4}) \qquad \boldsymbol{p_t U'(c_t) = \beta E[(p_{t+1} + y_{t+1})U'(c_{t+1})]}$$

$$(\mathbf{C.2}) \qquad p_t = \frac{1}{U'(c_t)} \beta E[(p_{t+1} + y_{t+1})U'(c_{t+1})]$$

$$(\mathbf{C.3}) \qquad p_t = \beta E\left[(p_{t+1} + y_{t+1})U'(c_{t+1})\frac{1}{U'(c_t)}\right]$$

$$(\mathbf{C.4}) \qquad p_t = \beta E\left[(p_{t+1} + y_{t+1})\frac{U'(c_{t+1})}{U'(c_t)}\right]$$

From equation (A.3) it is known that $U'(c_t) = c_t^{-\alpha}$

$$(\mathbf{C.5}) \qquad p_t = \beta E\left[(p_{t+1} + y_{t+1})\frac{c_{t+1}^{-\alpha}}{c_t^{-\alpha}}\right]$$

The consumption growth x_{t+1} is introduced through the definition $\frac{c_{t+1}}{c_t}$

$$(\mathbf{C.6}) \qquad p_t = \beta E[(p_{t+1} + y_{t+1})x_{t+1}^{-\alpha}]$$

The Mehra & Prescott model assumes that price p_t is a linear function of dividends y_t

$$(\mathbf{C.7}) \qquad p_t = wy_t$$

Recall that return on equity $R_{e,t+1} = \frac{p_{t+1} + y_{t+1}}{p_t}$. Combining this with equation (C.7) yields

$$(\mathbf{C.8}) \qquad R_{e,t+1} = \frac{wy_{t+1} + y_{t+1}}{wy_t} = \frac{y_{t+1}(w+1)}{wy_t} = \frac{y_{t+1}}{y_t}\frac{w+1}{w}$$

In equilibrium consumption c_t must equal asset payoff y_t, *so* $\frac{y_{t+1}}{y_t} = \frac{c_{t+1}}{c_t} = \text{consumption growth}, x_{t+1}$

$$(\mathbf{C.9}) \qquad R_{e,t+1} = x_{t+1}\frac{w+1}{w}$$

The expected equity return is therefore

$$(\mathbf{C.9}) \qquad E(R_{e,t+1}) = E(x_{t+1})\frac{w+1}{w}$$

Through combining equation (C.6) with (C.7) the expression $\frac{w+1}{w}$ is determined

$$(\mathbf{C.10}) \qquad wy_t = \beta E[(wy_{t+1} + y_{t+1})x_{t+1}^{-\alpha}]$$

$$(\mathbf{C.11}) \qquad wy_t = \beta E[(w+1)y_{t+1}x_{t+1}^{-\alpha}]$$

$$(\mathbf{C.12}) \qquad w = \beta E\left[(w+1)\frac{y_{t+1}}{y_t}x_{t+1}^{-\alpha}\right]$$

Then consumption growth x_{t+1} (as $\frac{y_{t+1}}{y_t} = \frac{c_{t+1}}{c_t}$) is substituted into the equation

$$(\mathbf{C.13}) \qquad w = \beta E[(w+1)x_{t+1}x_{t+1}^{-\alpha}]$$

$$(\mathbf{C.14}) \quad w = \beta E(w+1)x_{t+1}^{1-\alpha}$$

$$(\mathbf{C.15}) \quad \frac{w}{w+1} = \beta E x_{t+1}^{1-\alpha}$$

$$(\mathbf{C.16}) \quad \frac{w+1}{w} = \frac{1}{\beta E x_{t+1}^{1-\alpha}}$$

This definition is inserted in equation (C.9)

$$(\mathbf{C.17}) \quad E(R_{e,t+1}) = E(x_{t+1})\frac{1}{\beta E x_{t+1}^{1-\alpha}}$$

This yields **equation (2.8)**

$$(\mathbf{2.5}) \quad \boldsymbol{E(R_{e,t+1}) = \frac{E_t(x_{t+1})}{\beta E_t(x_{t+1}^{1-\alpha})}}$$

The corresponding return expression for the risk-free asset can be derived from the pricing relationship in equation (C.6)

$$(\mathbf{C.6}) \quad p_t = \beta E[(p_{t+1} + y_{t+1})x_{t+1}^{-\alpha}]$$

The price of the risk-free asset is defined as q

$$(\mathbf{C.19}) \quad q_t = \beta E[(p_{t+1} + y_{t+1})x_{t+1}^{-\alpha}]$$

The price of the asset at time *t+1* is known as there is no risk and equal to 1 implying: $q_{t+1} = p_{t+1} + y_{t+1} = 1$

$$(\mathbf{C.20}) \quad q_t = \beta E[1x_{t+1}^{-\alpha}]$$

The risk-free return, in line with the return on a risky asset, is defined as $R_{f,t+1} = \frac{p_{t+1} + y_{t+1}}{p_t}$ but as it is known that $p_{t+1}+y_{t+1} = 1$, this equates to $\frac{1}{q_1}$. Combining this with equation (C.20) yields **equation (2.7)**

$$(\mathbf{2.7}) \quad \boldsymbol{R_{f,t+1} = \frac{1}{\beta E[1x_{t+1}^{-\alpha}]}}$$

As a central assumption in the Mehra & Prescott model the growth rate of consumption x_t and dividends y_t are assumed lognormally distributed. The mean of a lognormal distribution is equal to $\bar{x} = e^{\mu_x + 1/2\sigma^2}$ where $\mu_x = E[\ln(x_t)]$, $\sigma_x^2 = Var[\ln(x_t)]$, and $\ln(x_t)$ is the continuously compounded growth rate of consumption. Therefore the expected growth rate is

$$(\mathbf{C.21}) \quad E(x_{t+1}) = e^{\mu_x + 1/2\sigma_x^2}$$

and

$$(\mathbf{C.22}) \quad E(x_{t+1}^{1-\alpha}) = (e^{\mu_x + 1/2\sigma_x^2})^{1-\alpha} = e^{(1-\alpha)\mu_x + (1-\alpha)^2 1/2\sigma_x^2}$$

Recall the expression for expected return on equity, equation (2.8)

$$(\mathbf{2.8}) \quad \boldsymbol{E(R_{e,t+1}) = \frac{E_t(x_{t+1})}{\beta E_t(x_{t+1}^{1-\alpha})}}$$

Inserting equation C.21 and C.22 gives **equation (2.9)**

$$(\mathbf{2.9})\qquad \boldsymbol{E(R_{e,t+1}) = \frac{e^{\mu_x+1/2\sigma_x^2}}{\beta e^{(1-\alpha)\mu_x+(1-\alpha)^2 1/2\sigma_x^2}}}$$

As $\ln\left(\frac{x}{y}\right) = \ln(x) - \ln(y)$ allows (2.9) to be rearranged to

$$(\mathbf{C.23})\quad \ln\left[E(R_{e,t+1})\right] = \ln(e^{\mu_x+1/2\sigma_x^2}) - \ln(\beta e^{(1-\alpha)\mu_x+(1-\alpha)^2 1/2\sigma_x^2})$$

Given that $\ln(xy) = \ln(x) + \ln(y)$

$$(\mathbf{C.24})\quad \ln\left[E(R_{e,t+1})\right] = \mu_x + 1/2\sigma_x^2 - [\ln(\beta) + (1-\alpha)\mu_x + (1-\alpha)^2 1/2\sigma_x^2]$$

$$(\mathbf{C.25})\quad \ln\left[E(R_{e,t+1})\right] = \mu_x + \frac{1}{2}\sigma_x^2 - \ln(\beta) - \mu_x(1-\alpha) - \frac{1}{2}(1-\alpha)^2\sigma_x^2$$

$$(\mathbf{C.26})\quad \ln\left[E(R_{e,t+1})\right] = \mu_x + \frac{1}{2}\sigma_x^2 - \ln(\beta) - \mu_x + \alpha\mu_x - \frac{1}{2}(1-\alpha)^2\sigma_x^2$$

$$(\mathbf{C.27})\quad \ln\left[E(R_{e,t+1})\right] = \mu_x + \frac{1}{2}\sigma_x^2 - \ln(\beta) - \mu_x + \alpha\mu_x - \frac{1}{2}\sigma_x^2(\alpha^2 - 2\alpha + 1)$$

$$(\mathbf{C.28})\quad \ln\left[E(R_{e,t+1})\right] = \mu_x + \frac{1}{2}\sigma_x^2 - \ln(\beta) - \mu_x + \alpha\mu_x - \frac{1}{2}\sigma_x^2\alpha^2 + \alpha\sigma_x^2 - \frac{1}{2}\sigma_x^2$$

This can be reformulated to **equation (2.10)**

$$(\mathbf{2.10})\quad \boldsymbol{\ln\left[E(R_{e,t+1})\right] = -\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2 + \alpha\sigma_x^2}$$

The corresponding return on a risk-free asset is found based on the same property of the lognormal distribution as in (C.22):

$$(\mathbf{C.29})\qquad E(x_{t+1}^{-\alpha}) = e^{-\alpha\mu_x+1/2\alpha^2\sigma_x^2}$$

Recall the expression for the risk-free return, equation (2.7)

$$(\mathbf{2.7})\qquad R_{f,t+1} = \frac{1}{\beta E[1x_{t+1}^{-\alpha}]}$$

Inserting the relation in C.29 yields **equation (2.11)**

$$(\mathbf{2.11})\qquad \boldsymbol{R_{f,t+1} = \frac{1}{\beta e^{-\alpha\mu_x+1/2\alpha^2\sigma_x^2}}}$$

As with the risky asset return this can be restated to:

$$(\mathbf{C.30})\quad \ln\left(R_{f,t+1}\right) = \ln(1) - [\ln(\beta) - \alpha\mu_x - 1/2\alpha^2\sigma_x^2]$$

And further more to give **equation (2.12)**

$$(\mathbf{2.12})\quad \boldsymbol{\ln\left(R_{f,t+1}\right) = -\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2}$$

The equity premium is then found as the difference between the expected risky asset return of equation (2.10) and the risk-free return equation (2.12)

$$(\mathbf{C.31}) \quad \ln\left[E\left(R_{e,t+1}\right)\right] - \ln\left(R_{e,t+1}\right) = -\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2 + \alpha\sigma_x^2 - (-\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2)$$

$$(\mathbf{C.32}) \quad \ln\left[E\left(R_{e,t+1}\right)\right] - \ln\left(R_{e,t+1}\right) = -\ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2 + \alpha\sigma_x^2 + \ln\beta - \alpha\mu_x + \frac{1}{2}\alpha^2\sigma_x^2)$$

This can be rewritten to **equation (2.13)**

$$(\mathbf{2.13}) \quad \boldsymbol{\ln\left[E\left(R_{e,t+1}\right)\right] - \ln\left(R_{e,t+1}\right) = \alpha\sigma_x^2}$$

Appendix D – Data source overview

Data Source overview

Category	Source	Accessed from
Equity data	MSCI	Bloomberg
CPI Data	IMF	Bloomberg
	Statistischen Bundesamtes Deutchland	Bloomberg
Consumption data	OECD	OECD iLibrary
Population data	IMF	Bloomberg
Risk-free data	Bloomberg	Bloomberg
	IMF	Bloomberg
	OECD	Bloomberg
	Reuters - Ecowin data	Ecowin database
	The national Bank of Belgium	http://www.nbb.be/belgostat/PresentationLinker?TableId=620000037&Lang=E
	The national Bank of Denmark	http://nationalbanken.statistikbank.dk/statbank5a/default.asp?w=1024
	The national Bank of France	http://www.banque-france.fr/gb/statistiques/taux/taux-interet.htm
	The national Bank of Norway	http://www.norges-bank.no/en/price-stability/historical-monetary-statistics/short-term-interest-rates/
	The national Bank of Sweden	http://www.riksbank.com/templates/stat.aspx?id=17187
	The Swiss national bank	http://www.snb.ch/en/iabout/stat/statpub/akziwe/stats/akziwe/akziwe_S1_Zins
	Bank of England	http://www.bankofengland.co.uk/mfsd/iadb/index.asp?Travel=NIxSTxTIx&levels=1&XNotes=Y&C=7U9&C=MO&XNotes2=Y&Nodes=X4051X4052X4074X41513X40727X3687X3764X3765&SectionRequired=I&HideNums=-1&ExtraInfo=false&Z0Xtop.x=50&Z0Xtop.y=4

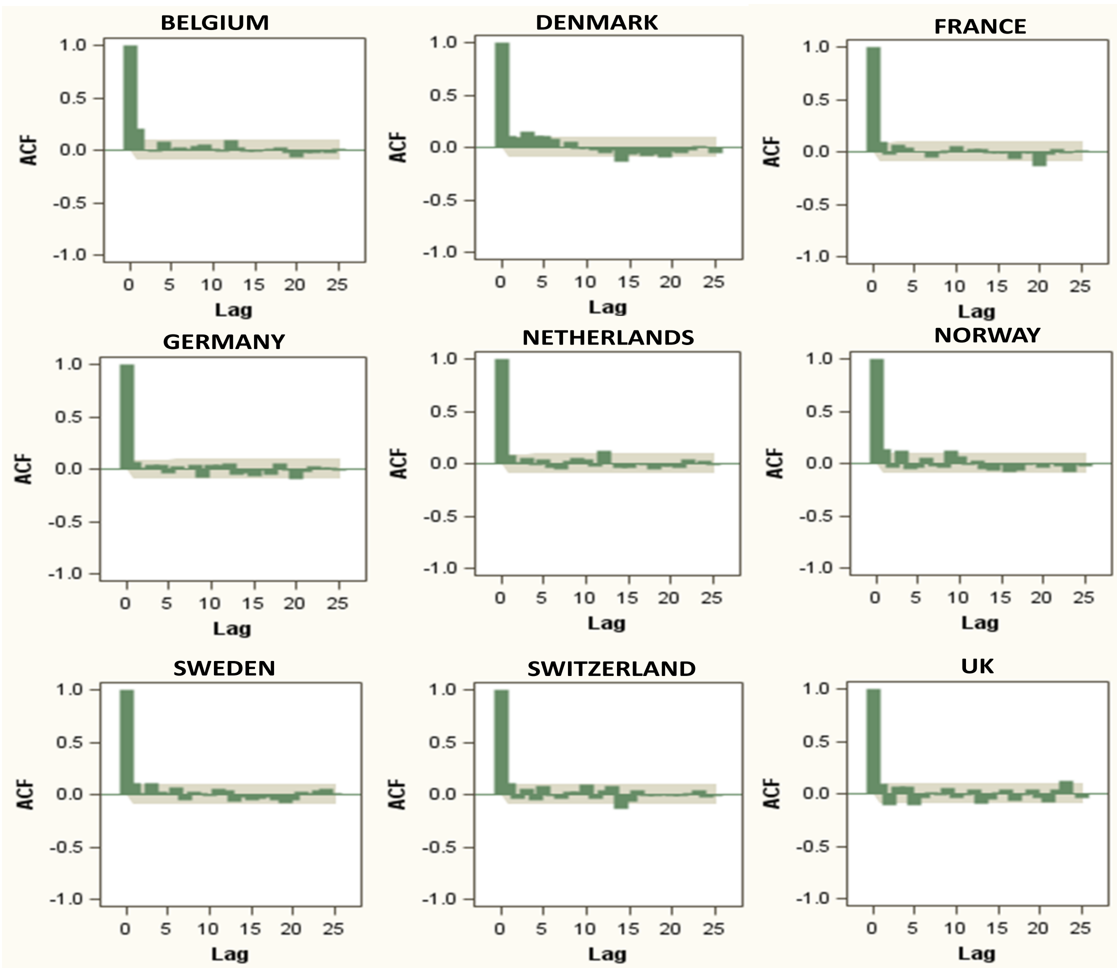
Appendix E – Data characteristics

Historical data characteristics

Main norminal data characteristics

Country	Risk free return		Equity return	
	Mean	Std.	Mean	Std.
Belgium	6.6%	1.7%	9.6%	21.1%
Denmark	8.0%	2.3%	12.0%	20.1%
France	7.1%	1.9%	9.7%	22.8%
Germany	5.2%	1.4%	7.4%	22.7%
Netherlands	5.2%	1.4%	9.9%	19.9%
Norway	7.6%	1.9%	10.8%	28.5%
Sweden	7.0%	2.0%	14.1%	25.4%
Switzerland	3.3%	1.3%	7.5%	19.2%
UK	7.8%	1.8%	11.1%	20.2%
Mean	6.4%	1.7%	10.2%	22.2%
	Per capita consumption growth		Inflation	
	Mean	Std.	Mean	Std.
Belgium	5.8%	2.1%	3.9%	1.8%
Denmark	6.1%	3.9%	4.8%	2.3%
France	6.5%	2.6%	4.7%	2.1%
Germany	4.7%	2.4%	2.9%	1.4%
Netherlands	5.1%	2.7%	3.5%	1.9%
Norway	7.4%	2.8%	5.1%	2.5%
Sweden	6.9%	3.3%	5.0%	2.6%
Switzerland	3.9%	1.9%	2.7%	1.8%
UK	8.4%	2.9%	6.2%	3.0%
Mean	6.1%	2.8%	4.3%	2.2%

Appendix F – Autocorrelation



Autocorrelation output

Country	1st Order		2nd Order		3rd Order		4th Order	
	LM	Prob > LM	LM	Prob > LM	LM	Prob > LM	LM	Prob > LM
Belgium	22.33	<.0001	23.54	<.0001	23.55	<.0001	27.37	<.0001
Denmark	5.70	0.017	9.05	0.011	18.64	0.000	21.41	0.000
France	4.51	0.034	4.91	0.086	7.73	0.052	8.29	0.081
Germany	2.23	0.135	2.24	0.326	3.39	0.336	3.85	0.427
Netherlands	4.08	0.043	4.10	0.129	5.36	0.147	5.58	0.233
Norway	10.12	0.002	12.35	0.002	22.06	<.0001	27.13	<.0001
Sweden	6.86	0.009	6.87	0.032	13.56	0.004	13.56	0.009
Switzerland	5.88	0.015	7.20	0.027	9.74	0.021	12.35	0.015
UK	5.16	0.023	11.81	0.003	16.65	0.001	17.26	0.002

Appendix G – Visual Basics programming

Main function:

```
Function ProspectUtility(Dates As Range, StockReturns As Range, Stockweight As Double, BondReturns As Range, Bondweight As Double, alpha As Double, beta As Double, gamma As Double, lambda As Double, delta As Double, InvestmentHorizon As Integer) As Variant

Dim i, N, m As Integer
N = Dates.Rows.Count

m = Application.WorksheetFunction.RoundDown(N / InvestmentHorizon, 0)

Dim CompDates()
ReDim CompDates(m - 1)

    For i = 1 To m
      CompDates(i - 1) = Dates(InvestmentHorizon * i)
    Next i


Dim StockReturnsComphorizon()
ReDim StockReturnsComphorizon(m - 1)

    StockReturnsComphorizon = CompoundReturns(StockReturns, InvestmentHorizon, N)


Dim BondReturnsComphorizon()
ReDim BondReturnsComphorizon(m - 1)

    BondReturnsComphorizon = CompoundReturns(BondReturns, InvestmentHorizon, N)


Dim PortfolioReturns()
ReDim PortfolioReturns(m - 1, 1)

    PortfolioReturns = PortfolioReturn(CompDates, StockReturnsComphorizon, BondReturnsComphorizon, Stockweight, Bondweight, m)


Dim v()
ReDim v(m - 1, 1)

    For i = 0 To m - 1
      v(i, 0) = PortfolioReturns(i, 0)

    If PortfolioReturns(i, 1) >= 0 Then
      v(i, 1) = PortfolioReturns(i, 1) ^ alpha

    Else:
      v(i, 1) = -lambda * (-PortfolioReturns(i, 1)) ^ beta

    End If

    Next i


Dim Sortetv()
```

```
ReDim Sortetv(m - 1, 1)

    Sortetv = DualSorter(v, 1)


Dim P, Px, Wp, Wpx, WPdiff, Vg As Double

    i = 0
    ProspectUtility = 0

    For i = 0 To m - 1

    If Sortetv(i, 1) >= 0 Then
      P = (m - i) / m
      Px = (m - i - 1) / m

    Else
      P = (i + 1) / m
      Px = i / m

    End If

    If Sortetv(i, 1) >= 0 Then
      Wp = (P ^ gamma) / ((P ^ gamma + (1 - P) ^ gamma)) ^ (1 / gamma)
      Wpx = (Px ^ gamma) / ((Px ^ gamma + (1 - Px) ^ gamma)) ^ (1 / gamma)

    Else
      Wp = (P ^ delta) / ((P ^ delta + (1 - P) ^ delta)) ^ (1 / delta)
      Wpx = (Px ^ delta) / ((Px ^ delta + (1 - Px) ^ delta)) ^ (1 / delta)

    End If


WPdiff = Wp - Wpx

Vg = WPdiff * Sortetv(i, 1)


ProspectUtility = ProspectUtility + Vg

Next i

End Function
```

Sub functions:

```
Function CompoundReturns(Data, H As Integer, ObsCount)

Dim i, j
Dim N, m

    N = ObsCount

    m = Application.WorksheetFunction.RoundDown(N / H, 0)

Dim rtn()
ReDim rtn(m - 1)

    If N = m Then
      For j = 0 To m - 1
```

```
            rtn(j) = Data(j + 1)

        Next j

    Else

        Dim C()
        ReDim C(H - 1)

          For j = 0 To (m - 1) * H Step H
          For i = 0 To H - 1
            C(i) = 1 + Data(j + i + 1)

          Next i

          rtn(j / H) = Application.WorksheetFunction.Product(C) - 1

        Next j

    End If

    CompoundReturns = rtn

End Function
```

```
Function PortfolioReturn(Dates, Asset1_Returns, Asset2_Returns, Asset1_Weight As Double, Asset2_Weight As Double, N As Integer)

Dim i As Integer

Dim Pfrtn()
ReDim Pfrtn(N - 1, 1)

    For i = 0 To N - 1
      Pfrtn(i, 0) = Dates(i)
      Pfrtn(i, 1) = Asset1_Weight * Asset1_Returns(i) + Asset2_Weight * Asset2_Returns(i)

    Next i

PortfolioReturn = Pfrtn

End Function
```

```
Function DualSorter(ByRef arrArray, DimensionToSort)

    Dim row, j, StartingKeyValue, StartingOtherValue, _
      NewStartingKey, NewStartingOther, _
      swap_pos, OtherDimension
    Const column = 1

    If DimensionToSort = 1 Then
        OtherDimension = 0
      ElseIf DimensionToSort = 0 Then
        OtherDimension = 1
      Else
        Response.Write "Invalid dimension for DimensionToSort: " & _
                "must be value of 1 or 0."

        Response.End
```

```
    End If

  For row = 0 To UBound(arrArray, column) - 1

    StartingKeyValue = arrArray(row, DimensionToSort)
    StartingOtherValue = arrArray(row, OtherDimension)

    NewStartingKey = arrArray(row, DimensionToSort)
    NewStartingOther = arrArray(row, OtherDimension)

    swap_pos = row

    For j = row + 1 To UBound(arrArray, column)
        If arrArray(j, DimensionToSort) < NewStartingKey Then
            swap_pos = j
            NewStartingKey = arrArray(j, DimensionToSort)
            NewStartingOther = arrArray(j, OtherDimension)
        End If

      Next

      If swap_pos <> row Then
        arrArray(swap_pos, DimensionToSort) = StartingKeyValue
        arrArray(swap_pos, OtherDimension) = StartingOtherValue

        arrArray(row, DimensionToSort) = NewStartingKey
        arrArray(row, OtherDimension) = NewStartingOther

      End If

  Next

DualSorter = arrArray

End Function
```